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Volume 16, Number 17 September 15, 1962

NUCLEAR SCIENCE ABSTRACTS

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Use of funds for printing this publication has been approved by the Bureau of the Budget, July 29, 1960.

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NUCLEAR SCIENCE ABSTRACTS

GENERAL AND MISCELLANEOUS

21866 (HW-73249) HANFORD FORMAL RESEARCH AND DEVELOPMENT REPORTS [FOR] 1961. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 1962. Contract AT(45-1)-1350. 64p.

The formal research and development reports issued and distributed during 1961 from the Hanford Atomic Products Operation are listed. Author, subject, and report number indexes are included. (M.C.G.)

21867 (UCRL-6523) THE SAPIR PROGRAM SYSTEM OF AUTOMATIC PROCESSING AND INDEXING OF REPORTS. Lester Douglas Turner (California. Univ., Livermore. Lawrence Radiation Lab.). May 27, 1961. Contract W-7405-Eng-48. 29p.

The rapidly increasing volume of new data in scientific and technical fields demands faster and better ways to communicate the new information to those concerned. A working system, System of Automatic Processing and Indexing of Reports (SAPIR), for doing this is described. SAPIR makes use of the Keyword-in-Context Index principle, by which certain keywords, together with surrounding words that act as modifiers, are selected from the titles of the technical publications. These keywords with their modifiers serve as index entries from each title, therefore, there will be as many index entries generated as there are keywords contained in the title. The index entries are sorted alphabetically by the keywords. The first letters of the keywords in each of the index entries form a column in the printed format, which makes scanning for the sought-after item easier. The SAPIR system is automatic and the list of citations is machine-generated on an IBM 1401 Computer. (auth)

21868 JAPANESE SCIENCE AND TECHNOLOGY. OTS Selective Bibliography. (Office of Technical Services, Washington, D. C.). July 1961. 37p. $0.10(OTS) (SB-477)

A selective listing of 692 reports and translations concerning the development of research and technology in Japan in the last 20 yr is presented. The references are arranged in alphabetical order by author under the following topics: biological and behavioral sciences, chemistry, chemical engineering, earth sciences, engineering, food and agriculture, machinery, materials, metallurgy, physics and mathematics, and patents. (M.C.G.)

21869 RUBBER (SUPPLEMENT TO CTR-321). (Office of Technical Services, Washington, D. C.). Feb. 1962. 22p. $0.10(OTS). (SB-494)

This bibliography contains a general coverage of rubber during the period 1956 to February 1962. The references come from reports listed in the two OTS semi-monthly abstract journals: U. S. Government Research Reports and Technical Translations. (N.W.R.)

BIOLOGY AND MEDICINE

General and Miscellaneous

21870 (DASA-1271) BIOLOGICAL EFFECTS OF BLAST. Technical Progress Report. Clayton S. White (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Dec. 1961. Contract DA-49-146-XZ-055. 121p.

Presented at the Armed Forces Medical Symposium, Field Command, DASA, Sandia Base, Albuquerque, N. Mex., Nov. 28, 1961.

The current state of knowledge relevant to biological blast effects was summarized in a selective manner. Initially, five problems of concern to those who would relate the environmental variations produced by nuclear weapons with biological response and hazard assessment were pointed out. Primary, secondary, tertiary, and miscellaneous blast effects were defined and selected interspecies experimental data of a physical and pathophysiological nature useful in estimating human response were presented. Tentative biological criteria defining safe levels of exposure were set forth as were survival curves for different conditions of exposure in Hiroshima. These were discussed along with the comparative variations in range of the free-field effects as they vary with explosive yield. The fundamental requirement for surviving seconds, minutes, and hours to abet survival for days, weeks, months, and years was emphasized along with the necessity for planning protective measures against all hazardous weapons effects as one attractive alternative for minimizing casualties and maximizing survival in the event of a nuclear war. (auth)

21871 BIOLOGY OF TUMOURS IN WISTAR RATS AFTER X-IRRADIATION. Karel Gross (Oncological Inst., Prague) and Bruno Schober. Acta Unio Intern. contra Cancrum, 18: 215-18(1962). (In English)

Tumor incidence in rats surviving whole-body irradiation was 10% against 4% in controls. There is no linear relation to dose; a low is seen between two peaks at 400 and 700 r. Irradiation may increase or decrease tumor incidence in single organs, and in the same organ the change in incidence may be dose-dependent. Spleen changes were especially studied. A pattern of spleen change considered almost pathognomonical for tumor bearing rats is described. The study also tends to confirm the defensive role of the spleen in neoplastic conditions, and its weakening by irradiation. (auth)

21872 SELECTION OF A NUMERICAL TECHNIQUE FOR ANALYZING EXPERIMENTAL DATA OF THE DECAY TYPE WITH SPECIAL REFERENCE TO THE USE OF TRACERS IN BIOLOGICAL SYSTEMS. Beatrice H. Worsley and Louis C. Lax (Univ. of Toronto). Biochim. et Biophys. Acta, 59: 1-24(May 7, 1962). (In English)

Typical sets of specific activity versus time data arising from physiological experiments involving tracers are analyzed. Curves involving sums of exponential terms are fitted to these data and compared with fitted polynomial forms. Numerical techniques utilizing exponential forms and the principle of least squares were developed especially for this problem as described in an earlier paper. These techniques have now been extended and applied to the results of human and animal experiments. Great care must be exercised in identifying the individually fitted parameters with physical constants. This is implied by the present study, and emphasized by a comparison of the statistical errors of the various fittings. Actual values of the fitted parameters are very sensitive to variations in the fitting technique. Values of functions derived from these parameters which have a physical interpretation, for example, the transfer rate of a chemical constituent into a biological compartment, are rather more stable under such variations. This is particularly true if the rates are found by extrapolation of fitted functions to the zero time of administration of the tracer to the system. However, calculated error bounds can sometimes be quite large. It would appear best to establish a uniform technique for running the experiments and analyzing the data and to consider as significant only differences between one group or subject and the next. (auth)

21873 RADIOACTIVATION AS A METHOD FOR PREPARING ^{75}Se-LABELLED SELENIUM COMPOUNDS. Kenneth P. McConnell (Univ. of Louisville, Ky.), Henry G. Mautner, and G. W. Leddicotte. Biochim. et Biophys. Acta, 59: 217-18(May 7, 1962). (In English)

Chemically pure 6-selenoquinone, 6-selenopurine, and selenocystine were activated by irradiation in the water-cooled compartment of a graphite reactor at a neutron flux of 7.5×10^{11} neutrons/cm^2/sec for 62 hr. After irradiation the Se^{75} content of the compounds was determined by use of a γ scintillation chamber. No evidence was found of decomposition during the activation procedure. (C.H.)

21874 ISOLATION AND PURIFICATION OF RP2-L, A NUCLEAR PROTEIN FRACTION OF THE WALKER 256 CARCINOSARCOMA. Harris Busch, Lubomir S. Hnilica, Su-chen Chien, Joseph R. Davis, and Charles W. Taylor (Baylor Univ., Houston, Tex.). Cancer Research, 22: 637-45(June 1962).

One hour after the injection of 5 μc of L-lysine-U-C^{14} into each of a group of rats bearing the Walker 256 carcinosarcoma, the acid-soluble proteins were extracted from nuclear preparations of the tumor. The proteins of these extracts were chromatographed on carboxymethylcellulose, with formic acid as the eluting agent. Rechromatography of 150 mg of RP2-L^1 on carboxymethylcellulose resulted in further purification of the proteins as determined by starch gel electrophoresis, amino acid analysis, N-terminal amino acids, and increase in specific activity. Since lysine comprises 14 per cent of the total amino acid residues, the proteins were classifiable as "slightly lysine-rich" histones. As the proteins were purified, the percentage of N-terminal proline increased. From the amino acid composition, sedimentation velocity, and diffusion constant, the molecular weight of the proteins in purified RP2-L was found to be 33,000. Starch gel electrophoresis of the purified product reveals the presence of one major and five minor protein bands, emphasizing the need for further improvement in methods for subfractionation of the bands. (auth)

21875 QUANTITATION OF MENSTRUAL BLOOD LOSS: A RADIOACTIVE METHOD UTILIZING A COUNTING DOME. W. Newlon Tauxe (Mayo Clinic and Mayo Foundation, Rochester, N. Y.). J. Nuclear Med., 3: 282-7 (July 1962).

A description has been given of a simple, accurate tech-

nique for the quantitation of menstrual blood loss, involving the determination of a three-dimensional isosensitivity curve and the fashioning of a lucite dome with cover to fit these specifications. Ten normal subjects lost no more than 50 ml each per menstrual period. (auth)

21876 COMPARATIVE COUNTING EFFICIENCIES OF Co^{57} B_{12} AND Co^{58} B_{12} FOR THREE COUNTING SYSTEMS USING TWO DETECTORS. Roland A. Allen and Booker T. Moore (Veterans Administration Hospital, Albany). J. Nuclear Med., 3: 300-4(July 1962).

$Co^{58}B_{12}$ and Co^{57} B_{12} were studied for relative efficiencies by integral and differential counting in three different systems. Data were presented for the efficiencies of each system. The advantage of differential counting was shown. It was found, from the counting point of view, that Co^{57} is significantly superior. (auth)

21877 FLUORINE-18: A NEW ISOTOPE FOR BONE SCANNING. Monte Blau, Willibald Nagler, and Merrill A. Bender (Roswell Park Memorial Inst., Buffalo). J. Nuclear Med., 3: 332-4(July 1962).

The possibility of detecting bone lesions by isotope scanning after the administration of F^{18} is discussed. The properties, preparation, and half life of F^{18} are reviewed. Eighteen patients with known bone lesions were given F^{18}. Concentrations of F^{18} in the lesions were adequate for good visualization. The uptake in normal bones was very low compared to sites of active bone lysis or deposition. In two patients uptake was demonstrated in sites of bone pain where no lesions were shown by x rays. The possibility of early metastases at these sites is considered. (C.H.)

Biochemistry, Nutrition, and Toxicology

21878 (ASD-TR-62-7-665) TOXICITY OF BERYLLIUM. Final Technical Engineering Report. J. Cholak, Robert A. Kehoe, Lee H. Miller, Frank Princi, and L. J. Schafer (Cincinnati. Univ. Kettering Lab.). Apr. 1962. Contract AF33(600)37211. 76p.

A review is given on the effects of the absorption of beryllium and specific measures designed to prevent illness and maintain health among persons who work with beryllium. The history of beryllium disease, hygenic standards, environmental control procedures, sampling and analytical procedures, housekeeping, personal hygiene and plant sanitation, are discussed and a medical program is outlined. Illustrations of ventilation controls are included. (auth)

21879 (TID-15818) EXTERNAL LOCALIZATION OF FOCAL INTRACRANIAL DISEASE EMPLOYING POSITRON-EMITTING ISOTOPES. William H. Sweet (Massachusetts. General Hospital. Neurosurgical Service, Boston). [1962]. Contract [AT(30-1)-1093]. 32p.

The use of isotopic tracer methods in studies of the brain is discussed. The basic technique for localization of focal intracranial disease using a positron scanner on each side of the head to detect the two annihilation quanta from positron-electron interactions is described. The advantages of positron scanning include high sensitivity at high resolution, very low background effects, uniform response, and As^{74} appears to be preferable to most materials used for external brain tumor localization. The advantages and disadvantages of radioactive isotopes of As, Cu, F, Rb, Zr, I, and Ga were studied. Direct clinical applications of positron scanning are discussed. (M.C.G.)

21880 UPTAKE AND RETENTION OF STRONTIUM-90 IN MOUSE TISSUES STUDIED BY WHOLE ANIMAL AUTORADIOGRAPHY AND IMPULSE COUNTING. [PART] I. A. Nilsson and S. Ullberg (Research Inst. of National Defence, Sundbyberg, Sweden and Royal Veterinary Coll., Stockholm). Acta Radiol., 58: 81-96(Apr. 1962). (In English)

The distribution and retention of radiostrontium after a single intraperitoneal injection in mice was investigated by autoradiography and by impulse counting. The technique is described and the findings discussed in detail. (auth)

21881 THE INTESTINAL UTILIZATION OF DOUBLY LABELED α-MONOPALMITIN. John M. Johnston and Jerry L. Brown (Univ. of Texas, Dallas). Biochim. et Biophys. Acta, 59: 500-1(May 21, 1962). (In English)

Doubly labeled α-monopalmitin was employed containing H^3 in the glycol portion of the molecule and C^{14} in the fatty acid. The doubly labeled α-monopalmitin was used in studies on the synthesis of glycerides by the intestine. Results offer convincing evidence for the intact incorporation of α-monopalmitin into higher glycerides by the intestine and indicate a mechanism for triglyceride synthesis in addition to the phosphatidic acid pathway. (C.H.)

21882 FURTHER WORK ON THE DISTRIBUTION OF Cs^{137} IN PIGS. K. G. McNeill and G. A. Robinson (Univ. of Toronto and Ontario Veterinary Coll., Guelph). Can. J. Biochem. and Physiol., 40: 835-6(June 1962).

Eight weanling boars were raised on Hog Grower, and also allowed to range in pasture until they were 6 months of age. They were then slaughtered, and portions of organs from all the pigs put into counting vessels. By means of scintillation spectrometry, the K^{40} and Cs^{137} contents of the organs were measured. The results are tabulated and data are compared with similar measurements made in 1960. (C.H.)

21883 PRODUCTION AND USE OF OXYGEN-15 AS A BIOLOGICAL TRACER. Sanford Winton Rudman (Washington Univ., St. Louis). Dissertation Abstr., 22: 2843-4 (Feb. 1962).

A system was constructed for the production, purification, and utilization of O^{15}. Abundant quantities of air tagged with O^{15} were generated by deuteron bombardment of air in a cyclotron in accordance with the reaction $N^{14}(d,n)O^{15}$. O^{15} compounds other than molecular oxygen and compounds containing radioactive isotopes other than O^{15} were removed by a series of traps and filters in the main gas line. Oxygen tagged with O^{15} behaved as molecular oxygen with a purity of over 99.4%. The half life of O^{15} was measured to be 2.25 minutes. This isotope decays by positron emission which prescribed the use of scintillation counting records for the detection of the annihilation radiation. Thus, a well counter, calibrated by means of standard sources, and pair of external probes were employed to trace and measure the distribution and concentration of radioactive oxygen in various biological systems. Different experiments confirmed that this active isotope enters into normal physiological processes as does its stable element. Uptake studies on C3H mice and guinea pigs revealed the relative oxygen accumulation in various organs, tumor and blood with respect to time and organ weight. The plateaus observed in the organ accumulation curves are attributable to a balance between the differential factors of decay, continued accumulation, and excretion. Clearance experiments suggested that the O^{15} was fixed in the tissues in the form of water. Additional studies of solubility and binding of O^{15} in plasma and blood in vitro and in the living dog confirmed

that O^{15} rapidly enters into oxidative metabolic processes being bound into the water of metabolism. Standard methods of biological statistics were applied to support the conclusions of the mice and guinea pig experiments. Also, a simple mathematical analysis of the curves describing the metabolism of O^{15} in the anesthetized dog was determined. As a consequence, values of H_2O^{15} diffusion rates, oxyhemoglobin desaturation rates, and rates of increase in metabolic water were calculated. These early studies indicated that a wide range of problems related to oxygen exchange and transfer in tissues may be investigated by use of O^{15} tagged air. In particular, a method for investigating rates of metabolism and water loss and for studying the kinetics of oxygen transport in the lungs and in the blood was made available. Also, studies with humans established the feasibility of using air tagged with O^{15} as a diagnostic tool in clinical medicine.

21884 ABSORPTION AND FETAL METABOLISM OF CESIUM 137 IN THE RAT. Wellington Moore, Jr. (Cornell Univ., Ithaca, N. Y.). Dissertation Abstr., 22: 2855(Feb. 1962).

Detailed studies in the rat were done on the following aspects of radiocesium metabolism: rates and mechanisms of gastrointestinal absorption, interrelationships with potassium, and magnitude and rates of placental transfer. Cs^{137} was absorbed rapidly and completely, after oral administration, from the gastrointestinal tract of the rat. Absorption occurred from all anatomical areas studied, with the small intestine being the most important site of absorption. The stomach and cecum absorbed only minute quantities. Using Dowex 50 resin as a trapping agent, total endogenous secretion was measured over the first hour after injection. Total endogenous secretion amounted to approximately 25% of the initial dose for the time period studied. Total absorption of Cs^{137} from the gastrointestinal tract amounted to 98% of the initial dose for the first hour after administration as estimated by taking endogenous secretion into consideration. The data indicated a gradient of absorptive efficiency with the duodenum having the highest rate of absorption and endogenous secretion and the colon the smallest. Increased concentrations of stable potassium or cesium in the dosing solutions studied, did not significantly affect absorption. However, gastric emptying time was increased with each increase in concentration of potassium or cesium. Cs^{137} was not transferred from the mucosal side to the serosal side of surviving intestinal segments against a concentration gradient using in vitro procedures. However, a net transfer did occur from the serosa to the mucosa, suggesting the presence of a mechanism for the transfer of Cs^{137} in this direction. Cs^{137} appeared rapidly in the fetus after oral administration to the dam. The fetal uptake was rapid for the first several hours and then decreased reaching a steady-state with maternal blood in approximately 16 hours. The general pattern of distribution was the same in the fetuses as in the dam, however, the accumulating ability of fetal tissues was less. The Cs^{137}/K ratio was greater in the dam than in the fetus. The percentage dose per gram of fetal tissue appeared to be independent of age or weight of the fetus. Cs^{137} migrated readily across the placental membrane. About 85% of that administered migrated to the dam after fetal injection, and about 25% migrated from the dam to fetus after maternal injection. The data provide a basis for understanding some aspects of the movement and metabolism of cesium in animals and man and the factors that govern its behavior.

21885 STABILITY STUDIES ON I^{131}-LABELED ALBUMIN. John U. Hidalgo and Samuel B. Nadler (Tulane Univ., New Orleans). J. Nuclear Med., 3: 268-72(July 1962).

It has been shown that low specific activity I^{131}-labeled albumin is more stable than high specific activity albumin at any temperature from 4 to 37°C. Even low specific activity albumin loses significant amounts of iodine tag after 8 to 10 days at 37°C. The results of these studies would seem to question the value of this tracer in long term albumin turnover studies. (auth)

21886 PLUTONIUM INHALATION STUDIES. IV. MORTALITY IN DOGS AFTER INHALATION OF $Pu^{239}O_2$. W. J. Bair and D. H. Willard (Hanford Atomic Products Operation, Richland, Wash.). Radiation Research, 16: 811-21(June 1962).

Twenty-eight beagle dogs deposited 1 to 130 μc of plutonium dioxide by inhalation. Two dogs were alive 21 months after exposure. All deaths occurred 2 to 14 months after exposure and were due to respiratory insufficiency. Lungs contained 95% and the bronchial lymph nodes 4% of the total plutonium content. Clinical symptoms included increased respiratory rates, 20% weight loss, and marked lymphopenia. Histopathologic effects were confined to lungs and bronchial lymph nodes. It was concluded that initial deposition of 0.1 μc of Pu^{239} per gram of lung would rarely cause death of a dog within a year. (auth)

21887 THE ACTION OF GONADS ON THE CONCENTRATION OF RADIO-IODINE BY THE SUBMAXILLARY GLAND OF C_3H MICE. J. L. Llach and J. H. Tramezzani (Instituto de Biologia y Medicina Experimental, Buenos Aires). Rev. can. biol., 21: No. 1, 23-31(Mar. 1962). (In English)

The I^{131} submaxillary/I^{131} blood ratio of normal C_3H male mice, receiving doses of 5 μc, is higher than the submaxillary/blood ratio of normal C_3H female mice. This sexual difference does not disappear after castration. The male castrated mice show a higher submaxillary/blood ratio than normal animals and no modification is observed in castrated females. Thus the sexual difference is more evident in castrated animals. Testosterone propionate, at doses of 10 μg or 20 μg during 14 and 13 days, respectively, restores in the male mice the changes produced by castration. Estradiol benzoate administered to the castrated female at doses of 0.5 μg and 5 μg during 6 and 7 days, respectively, decreases the submaxillary/blood ratio in relation to the given dose. (auth)

21888 DISTRIBUTION OF STRONTIUM IN THE BOVINE SKELETON. V. R. Bohman, M. A. Wade, and Clifton Blincoe (Univ. of Nevada, Reno). Science, 136: 1120-1 (June 29, 1962).

Five Hereford cattle, that had spent their entire lives in northeast Nevada under range pasture conditions, were slaughtered in May 1960. Seven bones were removed from each animal, ashed, Ca and Sr were separated, and the amounts of Ca, Sr, and Sr^{90} were determined for each bone. Data are tabulated for each bone and for different ages. The incisors contained more Ca and less Sr^{90} and the frontal bone was higher in both total Sr and Sr^{90} than the other bones. A calf had less Ca and Sr in its skeleton than older animals. The concentration of Ca apparently reached equilibrium in the skeleton at 1 year, while total Sr exhibited a progressive increase. The concentration of Sr^{90} apparently reached a maximum in the 2-year-old animal and remained about the same thereafter, although it was somewhat lower in older animals. (C.H.)

21889 CLAMS AS INDICATORS OF STRONTIUM-90. D. J. Nelson (Oak Ridge National Lab., Tenn.). Science, 137: 38-9(July 6, 1962).

Fresh water clams concentrate strontium-90 in their shells and may be used as indicators of the Sr^{90} contamina-

tion of their environment. Analysis of data derived from the specific activity of Sr^{90} in shells showed that Sr^{90} released to the Tennessee River system remained in solution and that concentrations to a distance of 500 miles from the release site can be predicted on the basis of the dilution of contaminated White Oak Creek water by uncontaminated Clinch-Tennessee River water. (auth)

Fallout and Ecology

21890 (TID-15982) CARBON-14 FIXATION IN POLLEN OF YELLOW LUPINE (LUPINUS LUTEUS LINN.). William G. Schwien, John C. Frazier, Herbert C. Moser, and James A. Gess (Kansas. Agricultural Experiment Station, Manhattan). [nd]. Contract AT(11-1)-1015. 12p.

Carbon-14 fixation studies were made on germinated pollen of yellow lupine to ascertain whether the chlorophyll reported to be in these grains was functional photosynthetically. Light and dark exposures to atmospheres containing 20 and 500 μc of carbon-14 labeled carbon dioxide were made for 1.5 and 45 minutes, respectively. The exposed pollen was extracted in 80% ethanol, the resulting extract reduced in volume, and chromatographed two dimensionally. When the chromatograms were cut into numbered small squares and their activity counted in an automatic sample counting system, a marked similarity was observed in the pattern of radioactivity from all exposures. Eluting and co-chromatographing this activity from the squares, with known standards, demonstrated labeling to be specific to certain intermediates of the Krebs cycle and their derived amine acids. The labeling in these intermediates and the absence of labeling in photosynthetic metabolites is strong evidence that only respiratory fixation of carbon-14 occurs in the germinated pollen of this variety of yellow lupine under the conditions of the experiment. (auth)

21891 (TID-16060) APPLICATIONS OF FUNDAMENTAL BIOLOGY TO THE NEEDS OF MAN. 4. RADIOECOLOGY AND THE STUDY OF ENVIRONMENTAL RADIATION. William E. Martin (California. Univ., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology). June 8, 1962. Contract AT-04-1-GEN-12. 70p.

A review is given of some of the ecological aspects of the problems of the atomic age which deal with the collection of data and the development of concepts to be used in making realistic, quantitative evaluations of the biological hazards, if any, resulting from increased environmental radiation due to fall-out. The major topics considered are: the kinds and amounts of natural and man-made sources of ionizing radiation in the biosphere; the formation and dispersal of fall-out, including a comparison of local, tropospheric and stratospheric fall-out patterns; the redistribution of fall-out materials by environmental processes, their accumulation by plants and animals, and their cycling in terrestrial food-chains; and the evaluation of potential biological hazards arising from small increases in external and internal exposure of organisms to ionizing radiation. (auth)

21892 THE STRONTIUM-90 CONTENT IN SOILS AND PLANTS OF THE TERRITORY OF THE DDR. H. Reissig (Technische Universität, Dresden). Kernenergie, 5: 191-6 (Mar. 1962). (In German)

The Sr^{90} contamination of soils and agricultural foods was first determined in 1960 for the territory of the DDR. Samples were taken at places at which the Meteorological and Hydrological Service of the DDR had determined for some years the total radioactive fall-out. If sampling of agricultural products was not possible, corresponding samples from neighboring farms were taken. The Sr^{90} poisoning of the soils varied from 4.7 to 23.1 mC/km². Of the agricultural products, the grass samples showed the highest and the potato samples the lowest Sr^{90} content in the solids. For grass and fodder samples, the known negative relationship between the Sr^{90}/Ca ratio in the plants and the concentration of exchangeable Ca in the soil was satisfied. The Sr^{90} uptake appears to be principally by the root system and less by the leaf surface of the plant. (tr-auth)

Radiation Effects on Living Tissues

21893 (AD-267635) EFFECTS OF CONTINUOUS LOW LEVEL COBALT 60 GAMMA RADIATION ON A MAMMALIAN CELL SYSTEM (thesis). Alfred Hellman (Michigan. Univ., Ann Arbor). 1961. 129p.

The development of a sensitive cell culture system which would respond rapidly and reproducibly to low levels of chronic gamma radiation was undertaken. Prolonged irradiation of L-M mouse cells resulted in an increased generation time which was quantitatively related to the dose rate. Other alterations noted were changes in cell viability, biochemical activity, and morphology. A reduction in incubation temperature from 35 to 30°C significantly enhanced the radiation effects, tripling the generation time and appreciably lengthening the lag phase of the irradiated population over that of the control. Failure of catalase to protect against continuous low-level gamma radiation, although it was able to neutralize added hydrogen peroxide, indicated that radiation damage was most likely due to intracellular events and not related extracellular peroxide. Screening of several potential protective agents was also carried out. The potential use and significance of this cell culture system are discussed. 157 references are given. (P.C.H.)

21894 (AD-268846) CHRONIC EFFECTS OF IONIZING RADIATION ON THE HEMATOPOIETIC SYSTEM. Progress Report. June 1, 1960–May 31, 1961. Charles E. Brambel (University of Notre Dame, Notre Dame, Ind.). Contract DA-49-007-MD-652. 86p.

Juvenile female rats were exposed continuously to two different levels of radiation from a point source of 5.7 curie Co^{60} (100 and 276 r/23 hour day). At the time of death of all the animals, the total accumulated dose for the two levels was 4000 roentgens. The survival times were forty days and fifteen days, respectively. The growth curves for the different levels are compared. A decrease in growth as a function of dose rate was observed. Animals living in an environment of 23 r/day survived a total accumulated dose of over 12,000 roentgens. The results of a comprehensive microscopic and quantitative examination of the hematopoietic system at selected intervals during the course of exposure to ionizing radiation were recorded Data are tabulated for peripheral blood, bone marrow, spleen, lymph gland, and thymus. Erythrocyte size distribution in relation to progressive radiation exposure and associated with hemorrhagic manifestations is reported. The incidence, time of appearance, and distribution of hemorrhagic complications is recorded from autopsy findings. (auth)

21895 (AD-266956) A STUDY OF THE BIOLOGICAL EFFECTS OF HIGH INTENSITY MICROSECOND PULSES OF X-IRRADIATION AS DETERMINED BY THE POST IRRADIATION TESTICULAR WEIGHT LOSS IN MICE. Final Technical Report, October 1, 1957–September 30, 1958—April 1, 1959–March 31, 1960. J. L. Boling, R. L.

Floyd, and F. M. Charbonnier (Linfield Coll., McMinnville, Ore. Research Inst.). Contracts DA-49-007-MD-901 and DA-49-193-MD-2014. 57p.

The exposure of biological materials to high dose rate x irradiation was made practicable by the recent development of T-F emission cathodes which permit the construction of high current x-ray tubes. This report presents the design and theoretical considerations of x ray production and dose distribution for a tube with a cylindrical transmission target surrounding a reentrant cavity in which material may be placed for irradiation. X-ray dose measurements at the high dose rates achieved in the reentrant cavity required the design and calibration of a suitable dosimeter. A group of 53 CAF1 mice were exposed to microsecond pulses of x radiation at dose rates of 17.1 or 23.1×10 to the 6th power r/sec. Exposure was made in a single pulse or in 2, 3, or 5 pulses with 10 minute intervals between pulses. The dose-response curve for 28 day post irradiation testicular weight loss was determined. Comparison of these data with data taken from the literature for testicular weight loss following x irradiation at relatively low dose rates suggests that the level of testicular damage induced by the high intensity x irradiation used is roughly comparable with that reported for low intensity experiments. (auth)

21896 (AECL-1509) GENETICS AND THE GENETIC EFFECTS OF RADIATION (GIVEN AT CARLETON UNIVERSITY, OTTAWA, ONTARIO, JANUARY 17, 1961). Howard B. Newcombe (Atomic Energy of Canada Ltd., Chalk River, Ont.). Apr. 1962. 12p.

The normal behavior of the genes and chromosomes and the roles that they play in influencing our lives are reviewed. The changes produced by irradiation and their possible human significance are discussed. (auth)

21897 (AECL-1510) THE EFFECTS OF RADIATION ON THE ANIMAL CELL (GIVEN AT CARLETON UNIVERSITY, OTTAWA, ONTARIO, DECEMBER 13, 1960). J. F. Whitfield (Atomic Energy of Canada Ltd., Chalk River, Ont.). Apr. 1962. 21p.

A short review is presented of some of the effects of radiation on cells, particularly mammalian cells irradiated in vitro. (auth)

21898 (AF-SAM-61-5) EFFECTS OF CHRONIC LOW-LEVEL IRRADIATION ON MICE. Loren D. Carlson, Leo K. Bustad, Frances Replogle, and Beulah Uland (Washington. Univ., Seattle). Jan. 1962. 22p.

Issued by School of Aerospace Medicine, Brooks AFB, Tex.

A facility for low-level irradiation with a Co^{60} source is described. Mice were irradiated at 0.01 r/hr and 0.2 r/hr for 8 hours of the day for 100 and 200 days. Following a challenge dose of irradiation of 50 r and 300 r, studies of weight, oxygen consumption, lymphocyte number, $LD_{50/15}$, and response to heat stress failed to show physiologic changes that might be related to a repair phenomenon or might differentiate the preirradiated animals from the control animals. (auth)

21899 (AFSWP-920) PROGRESS REPORT [ON PARTIAL-BODY IRRADIATION]. (Smith (E. H.) and Co., Silver Spring, Md.). [1956]. Contract DA 49-007-md-504. 23p. (AD-268002)

Results are summarized from a series of studies on the effects of partial-body shielding on the radiosensitivity of mice and rats. Data are tabulated from studies on the effect of spleen protection on mortality following x irradiation, the sensitivity of the abdomen of rats to x irradiation, the effects of shielding of various tissues or organs on the recovery of mice from radiation injury, and genetic modification of the response to spleen shielding in irradiated mice. (26 references) (C.H.)

21900 (ASD-TR-61-534) CHRONIC EFFECTS OF CONTINUOUS LOW-LEVEL GAMMA RADIATION UPON B VITAMIN REQUIREMENTS. B. H. Ershoff and T. M. Graham (Western Biological Labs., Culver City, Calif.). Oct. 1961. Contract AF33(616)-7090. 51p. (AD-271474)

Immature male rats were fed a highly purified diet containing low, medium, and high doses of the B vitamins. A fourth group was fed a natural food stock ration. Animals were exposed for periods up to 17 weeks to gamma irradiation from a Cesium-137/Barium-137 source at levels of 0, 3, 30, 300, and 500 r per week. Average length of survival at the 500 r per week level was significantly longer for rats fed the stock ration than for rats fed the purified diets. No significant difference in growth increment, appearance, organ weights or length of survival attributable to differences in B vitamin content were observed among the various groups. General animal activity measured by an open field test decreased with exposure to radiation up to 8 weeks duration while changes in learning ability were noted after 17 weeks. The composition of the diet employed was without significant effect on activity or learning performance on either irradiated or nonirradiated rats. (auth)

21901 (BNL-727) MEDICAL SURVEY OF RONGELAP PEOPLE SEVEN YEARS AFTER EXPOSURE TO FALL-OUT. Robert A. Conard, H. Eugene MacDonald, Leo M. Meyer, Stanton Cohn, Wataru W. Sutow, David Karnofsky, A. A. Jaffe, and Ezra Riklon (Brookhaven National Lab., Upton, N. Y.). May 1962. Contract [AT(30-2)-Gen-16]. 93p.

Results of a medical survey of the people of Rongelap in the Marshall Islands, carried out in March 1961, 7 years after the accident, are presented. A total of 267 people was examined, most of them on Rongelap Island and some at Kwajalein and Majuro Atolls. Physical examinations showed no acute illnesses present nor any diseases which could be directly associated with radiation effects. However, it was noted that several of the older people, particularly in the exposed group, were becoming quite feeble and helpless. Residual skin changes in areas previously showing lesions from fall-out were present with certainty in about 10 people. Dental examinations revealed no differences between the exposed and unexposed group. Examinations for the detection of such late effects of radiation as cancer and leukemia revealed no evidence of malignancies in any of the people, exposed or unexposed. Results of growth and development in children and hematological studies are also given. (P.C.H.)

21902 (CNEN-133) RESEARCH IN PROGRESS ON BIOLOGICAL AND PHYSICO-CHEMICAL PROPERTIES OF THE TEMPERATE PHAGE α. S. Aurisicchio, A. Coppo, P. Donini, C. Frontali, F. Graziosi, and G. Toschi (Italy. Comitato Nazionale per l'Energia Nucleare, Rome). June 1961. 39p.

The physico-chemical study of the particles of phage alpha, and of DNA purified by them, evidenced peculiar properties which differentiate it from other temperate phages. These properties, concerning the phage radiosensitivity and its DNA structure, were studied with various techniques, such as autoradiography, electron microscopy, analytical ultracentrifugation, spectrophotometry, and mutagenesis induced by HNO_2 treatments. (auth)

21903 (COO-225) RESEARCH IN RADIOBIOLOGY. Annual Report of Work in Progress on the CHRONIC TOXICITY PROGRAM. Thomas F. Dougherty (Utah. Univ.,

Salt Lake City. Coll. of Medicine). Mar. 31, 1962. Contract AT(11-1)-119. 136p.

Separate abstracts were prepared on 8 sections of this report. Data are also included on the status of dogs at various time intervals following the injection of various doses of Ra^{226}, Pu^{239}, Ra^{228}, Th^{228}, and Sr^{90}. (C.H.)

21904 (COO-225(p.31-42)) ANATOMICAL DISTRIBUTION OF RADIATION-INDUCED FRACTURES IN BEAGLES. G. N. Taylor, W. R. Christensen, W. S. S. Jee, C. E. Rehfeld, and W. Fisher (Utah. Univ., Salt Lake City. Coll. of Medicine).

The anatomical distribution of bone fractures in beagles resultant to retained burdens of Ra^{226}, Ra^{228}, or Pu^{239} indicated trends that were unique for the respective radionuclides. Pu^{239} induced the lowest number of limb bone fractures. Ra^{228} produced the highest total incidence and the widest anatomical distribution. The Ra^{226} cases more nearly resembled those of Ra^{228}, but the total number and distribution of fractures was lower. Involvements of the rib cage suggested patterns that were specific for the given radionuclides. (auth)

21905 (COO-225(p.43-7)) ELECTROCARDIOGRAM EVALUATION OF BEAGLES WITH RETAINED RADIONUCLIDE BURDENS. G. N. Taylor, C. E. Rehfeld, P. Petermann, and K. Crook (Utah. Univ., Salt Lake City. Coll. of Medicine).

Evaluation of the electrocardiograms of beagles with retained burdens of Ra^{226}, Ra^{228}, Pu^{239}, Th^{228}, or Sr^{90} did not reveal any significant effect on the respective wave patterns or the time intervals of the P wave, PR segment, PR interval, or QRS interval. Maximum injected dose levels studied were as follows: 3.0 μc/kg Ra^{226}, 10.0 μc/kg Ra^{228}, 0.3 μc/kg Th^{228}, 0.3 μc/kg Pu^{239}, and 100 μc/kg Sr^{90}. (auth)

21906 (COO-225(p.62-72)) STUDIES OF THE OXIDATION STATES OF Pu^{239} IN INJECTION SOLUTIONS. F. W. Bruenger, D. R. Atherton, and Betsy J. Stover (Utah. Univ., Salt Lake City. Coll. of Medicine).

Combined precipitation and spectrophotometric methods for evaluating the oxidation states of Pu^{239} are described. This Pu^{239} was in a citrate complex used in the injection of experimental animals. (auth)

21907 (COO-225(p.76-83)) TOTAL BODY GAMMA-RAY COUNTING OF PLUTONIUM-239. R. D. Lloyd, C. W. Mays, W. Fisher, and R. Hintze (Utah. Univ., Salt Lake City. Coll. of Medicine).

The infrequent gamma-rays produced in the radioactive decay of Pu^{239} have been used to assay the plutonium content of living dogs. Unlike the more abundant 17 kev x-rays which are almost completely absorbed within a large animal's body, the γ-rays at 100 kev and 380 kev can be employed in the measurement of Pu^{239} in the skeleton. Beagles containing 0.1 to 28 μc Pu^{239} were positioned in an arc 33 cm from an 8" × 4" NaI (Tl) detector inside a steel room with 6" thick walls. For counting periods of 30 minutes, mean deviations of 0.6 μc Pu^{239} at 100 kev and 2.1 μc Pu^{239} at 380 kev were obtained. (auth)

21908 (COO-225(p.88-9)) THE HALF-PERIOD OF Ra^{224} (THORIUM-X). R. D. Lloyd, C. W. Mays, D. R. Atherton, and D. O. Clark (Utah. Univ., Salt Lake City. Coll. of Medicine).

The half-period of Ra^{224} has been determined to be 3.62 ± 0.01 days by serial gamma-ray counting. This is not greatly different from the 3.64 day value reported over 30 years ago. (auth)

21909 (COO-225(p.90-1)) THE HALF-PERIOD OF Th^{228} (RdTh). C. W. Mays, D. R. Atherton, R. D. Lloyd, and D. O. Clark (Utah. Univ., Salt Lake City. Coll. of Medicine).

The half-period of Th^{228} was determined to be 1.908 ± 0.004 yr by serial γ-ray counting and 1.924 ± 0.020 yr by serial α-particle counting. These values confirm the accepted value of 1.910 ± 0.002 yr of Kirby, Grove, and Timma. (auth)

21910 (COO-225(p.92-105)) THE HALF-PERIOD OF Ra^{228} (MESOTHORIUM). C. W. Mays, D. R. Atherton, R. D. Lloyd, H. F. Lucas, Jr., Betsy J. Stover, and F. W. Bruenger (Utah. Univ., Salt Lake City. Coll. of Medicine).

Using 7 independent evaluations, the half-period of Ra^{228} was determined to be 5.75 ± 0.03 yr. (auth)

21911 (COO-225(p.109-21)) ALTERATION OF THE METABOLISM OF THE BEAGLE BY RADIONUCLIDES. D. H. Taysum, D. Brammer, and C. E. Rehfeld (Utah. Univ., Salt Lake City. Coll. of Medicine).

Subjective changes in the appearance of beagles injected with bone-seeking radionuclides prompted the examination of their metabolism by means of calorimetry. It was observed that radionuclide-burdened dogs produced approximately 10% more calories of heat per liter of oxygen consumed than did their controls. Respiratory quotient and body temperature were not significantly altered by mean skeletal dose rates ranging up to 10 rads per day. The change in metabolism was seen to precede the appearance of bone cancer. (auth)

21912 (NP-11648) MEETING WITH EXPERTS ON SOMATIC AND GENETIC RADIATION EFFECTS, MUNICH 1959. Transactions, International Commission on Radiological Protection (ICRP). (International Commission on Radiological Protection). 65p.

Ten papers are presented that cover the results of recent studies on the somatic and genetic effects of radiation. Emphasis is placed on dose-effect relations at low levels of radiation exposure. New standards for permissible radiation exposure are considered based on the concept that there is no dose threshold for the induction of some type of somatic damage. New measures of radiation protection are discussed with emphasis on the reduction of gonad dose during diagnostic exposure. Both the hazards and benefits of medical exposure are reviewed. Data are included from a number of studies on the incidence of leukemia and cancer in patients exposed to various levels of radiation. An automatic computer method for population surveys is described and applications in studies on the somatic effects of low doses of radiation are discussed. A procedure is described for the radioautographic study of I^{131} metabolism in rats killed by immersion in liquid nitrogen and maintained in a frozen state while a nuclear emulsion is applied to frozen sections. This method demonstrated an intense gastric secretion of iodine a few minutes after injection, considerable final activity of the hairs and fur, cutaneous fixation, and concentrations of I^{131} in salivary and lachrymal secretions. It is suggested that the systematic examination of the saliva of contaminated persons would give valuable information on body levels. (C.H.)

21913 (NP-11750) A STUDY OF GROWTH, VARIOUS ASPECTS OF SKELETAL STATUS, AND RATE OF FRACTURE HEALING IN THE ALBINO RAT SUBJECTED TO RADIATION AND DIETARY DEFICIENCIES. Progress Report No. III. (Texas Woman's Univ., Denton. Nelda Childers Stark Lab. for Human Nutrition Research; Texas. Agricultural and Mechanical Coll., College Station. Engineering Experiment Station. Radiation Biology Lab.; and

Texas. Agricultural and Mechanical Coll., College Station. Research Foundation). Aug. 31, 1960. 173p.

Results to date are summarized for a series of studies on the effects of radiation and various dietary deficiencies on the skeleton and rate of fracture healing in rats. Experimental procedures are described. Bone healing was determined by radiographic and histological methods, x-ray absorption measurements, bone density measurements, and chemical analysis of bone ash. (C.H.)

21914 (RADC-TN-61-226) OCCURRENCE OF LENTICULAR IMPERFECTIONS IN THE EYES OF MICROWAVE WORKERS AND THEIR ASSOCIATION WITH ENVIRONMENTAL FACTORS. Progress Report, February 1960–July 1961. M. Zaret, S. Cleary, B. Pasternack, and M. Eisenbud (New York Univ.-Bellevue Medical Center, New York. Inst. of Industrial Medicine). Nov. 27, 1961. Contract AF30(602)-2215. 113p. (AD-266831)

Ophthalmological examinations were made on personnel at installations encompassing a variety of types of microwave operations including research and development, operation installation, maintenance, and testing of microwave equipment. The sampling procedure used in the survey provided a partially representative population of microwave workers, including individuals of various ages and with varying kinds and degrees of microwave exposure. A total of 475 exposed and 359 control personnel were examined. Estimations were made of the exposure histories of all personnel. Four of the 5 lenticular defects recorded appear to be related to microwave exposure. Preliminary statistical analysis of the data obtained from the eye examinations and environmental histories indicate there is a small but statistically significant difference between mean eye scores of the total exposed and control groups when adjusted for age. The differences were not significant clinically. (C.H.)

21915 (TID-16010) THE EFFECTS OF BRAIN IRRADIATION, FEMUR IRRADIATION, AND STARVATION ON MAZE LEARNING IN RATS. William J. Arnold and James B. Cho (Nebraska. Univ., Lincoln). [1962]. Contract AT(11-1)-249. 3p.

Studies of radiation effects on maze learning in rats indicated that increased hunger drive following radiation sickness can account for the facilitation of maze performance in brain irradiated rats. Detrimental effects of brain irradiation can also be masked by increased hunger drive following radiation sickness. Femur irradiation did not produce effects comparable to those of brain irradiation either in terms of radiation sickness and consequent weight loss or in terms of maze performance. (P.C.H.)

21916 (UCRL-10181) EFFECTS OF GLYCEROL AND OF ANOXIA ON THE RADIOSENSITIVITY OF HAPLOID YEASTS TO DENSELY IONIZING PARTICLES. Thomas R. Manney, Tor Brustad, and C. A. Tobias (California. Univ., Berkeley. Donner Lab.). Apr. 18, 1962. Contract W-7405-eng-48. 24p.

The radiosensitivity of haploid yeast (Saccharomyces cerevisiae) was measured over the range of LET from 20 Mev g^{-1} cm^2 to 5500 Mev g^{-1} cm^2 under four sets of conditions: air atmosphere in buffer solution, N_2 atmosphere in buffer solution, air atmosphere in 6 M glycerol solution, and N_2 atmosphere in 6 M glycerol solution. Treatment with 6 M glycerol was found to protect cells irradiated in anoxia by an additional factor of about 1.9 throughout the range of LET studied. Experiments designed to study the kinetics of this effect were performed. The maximum protective effect was not seen until the cells had been exposed to glycerol for about 10 minutes, whereas the water was apparently removed much faster. The results are discussed in relation to current models of radiobiological action. A comparison is made with other reported results. (auth)

21917 (USNRDL-TR-556) DEVELOPMENT OF TRANSPLANTATION ISOANTIGENS IN THE MOUSE EMBRYO AND TROPHOBLAST. M. L. Tyan and L. J. Cole (Naval Radiological Defense Lab., San Francisco). Apr. 3, 1962. 15p.

Female LAF_1 mice were mated with BALB/c males, and the pregnancies were surgically interrupted at various times of gestation. The embryos were extirpated, homogenized in Tyrode's solution, and equal quantities were injected subcutaneously into the mother and into a paired virgin LAF_1 female. One week following surgery and/or injection the mice were exposed to a lethal dose of whole-body x radiation (870 rad). Within 2 hours, each received an intravenous injection of $6-9\times10^6$ bone marrow cells derived from male BALB/c mice. The presence of paternal transplantation immunity antigens in the injected fetal tissue was indicated by death (within 21 day postirradiation) of the recipient mice, due to bone marrow rejection. Transplantation immunity antigens were detected in the developing mouse embryo as early as the 1 day pregnancy embryo. Twenty-one day mortalities following the injection of fetal tissue into nonpregnant female mice were as follows: 1st trimester–39%; 2nd trimester–81%; 3rd trimester –98%. The data also show that the pregnant mother is to some extent immunologically non-reactive, since the injection of 1st trimester fetal tissue in this case elicited no 21-day mortality (0 out of 22). However, when 2nd and 3rd trimester fetal tissue was injected into the pregnant mothers, 21-day mortality was 66% and 82%, respectively. Therefore the maternal tolerance of the embryo seems best explained by the presence of an immunologically inert barrier of trophoblastic cells. (auth)

21918 (USNRDL-TR-560) STUDIES ON RADIATION-INDUCED CHIMERAS. EARLY DEVELOPMENT OF GRAFT-TO-HOST TOLERANCE. PREVENTION OF SECONDARY DISEASE BY ISOANTISERUM AND PRE-IRRADIATION OF MARROW DONOR. L. J. Cole and W. E. Davis (Naval Radiological Defense Lab., San Francisco). Apr. 30, 1962. 18p.

Radiation bone marrow chimeras were prepared by injecting marrow cells from adult C3H strain donors into lethally x irradiated (880 rad) LAF_1 mice. It was found that spleen cells from these chimeras (removed 35 to 57 days postirradiation) did not reject either donor (C3H) or host (LAF_1) type marrow cells, when transferred to other lethally x irradiated recipients, but were able to reject marrow of a third inbred strain (BALB/c). Similarly, in a series of parental-F_1 hybrid lymphoid cell chimeras, spleen and lymph node cells from these chimeras (as early as 5 to 10 days after establishment of chimerism) in no instance elicited secondary disease deaths when transferred to new irradiated LAF_1 hosts. Yet these same cell populations were immunologically competent, as shown by their capacity to reject homologous (C3H strain) bone marrow. Thus, these cell populations have developed specific tolerance (i.e., nonreactivity) for their primary LAF_1 hosts as early as 1 week following initial transplantation. C3H marrow donor mice were exposed to a single sublethal dose of x rays (400 rad); 12 or 16 days later their marrow was removed and injected into lethally x irradiated LAF_1 recipients $(22\times10^6$ cells injected per mouse). The incidence of secondary disease deaths (at 120 days) in these series was 0 out of 11, and 1 out of 3; in controls which received marrow from nonirradiated C3H donors,

6 out of 17 were dead by 120 days. Two additional groups of bone marrow chimeras received intravenous injections of isoantiserum (anti-C3H) at 16 and 18 days, or at 46 and 48 days after marrow infusion. No secondary disease deaths were observed in 17 mice thus treated by 7 months postirradiation. It is concluded that specific graft-to-host tolerance may develop relatively early in radiation chimeras that it is possible to prevent or eliminate secondary disease in homologous radiation chimeras by suitable preirradiation of the marrow donors, and by injection into the chimeras of specific isoantiserum directed against the marrow donor. (auth)

21919 (JPRS-14140) ELECTRON MICROSCOPE STUDY OF DNA. PART I. MOLECULAR MORPHOLOGY OF DEOXYRIBONUCLEIC ACID. PART II. CHANGE IN THE MOLECULAR MORPHOLOGY OF DEOXYRIBONUCLEIC ACID AS A RESULT OF IONIZING IRRADIATION. A. M. Tongur, A. L. Zaides (Zaydes), I. G. Stoyanova, and A. G. Pasynskii (Panyskiy). Translated from Vysokomolekulyarnye Soedineniya, 4: No. 1, 140-4(1962). 9p.

I. Investigations of DNA specimens with the electron microscope showed a predominance of linear thread-like particles. Electron microscopic studies of wet specimens revealed that the particles have an analogous configuration in solution. The phenol method for the isolation of DNA caused important structural changes in its particles. II. As a result of x irradiation (2×10^5 r) of various DNA specimens ($M = 4.5 \times 10^6$), in addition to the breaking of the fibers into short chains, a large number of coiled globular particles (dia = 100 to 150 Å) were formed, which are usually observed for the various forms of denaturation of DNA and appear to be a result of the rupture of hydrogen bonds in the DNA molecule. It is believed that this process is highly important in the action of ionizing radiation on DNA. (P.C.H.)

21920 EFFECT OF ROENTGEN RAYS ON THE ULTRASTRUCTURE OF REGENERATING RAT LIVER CELLS. J. M. G. Davis (Univ. of Cambridge, Eng.). Acta Radiol., 58: 129-40(Apr. 1962). (In English)

The effect of a dose of 450 roentgen on regenerating liver cells is to cause the disappearance of all alpha cytomembranes and glycogen. This loss is accompanied by complete cytoplasmic vacuolation. The cytoplasm remains vacuolated for about 9 to 10 hours after irradiation but after this new alpha cytomembranes and glycogen are formed. (auth)

21921 EFFECT OF ROENTGEN IRRADIATION ON THE ELASTICITY OF FROG SKIN. R. M. Bergstroem, R. Blåfield, and A. Salmi (Univ. of Helsinki). Acta Radiol., 58: 141-7(Apr. 1962). (In English)

The elasticity of roentgen irradiated (20,000 to 150,000 r) frog skin was studied by determining the area-pressure curves produced by distending the tissue. The effect of the irradiation was one of relaxation. Histologic examination by light microscopy did not reveal proportional structural alterations. (auth)

21922 EFFECT OF RADIATION ON VITAMIN B_1 METABOLISM. (ENGLISH TEXT). Y. Ueno (Kyoto Univ. Faculty of Medicine). Acta Schol. Med. Univ. Kioto, 37: No. 1, 1-24(1960).

Vitamin B_1 metabolism in the living organism is unfavorably affected by radiation. The blood level of B_1 decreased immediately after irradiation, increased after 6 hours and then decreased again after 3 days. Urinary excretion of B_1 increased immediately after radiation and decreased after 6 hours, and was still low even after 14 days. The B_1 level in the liver decreased immediately after irradiation and reached a minimum after 3 days. The B_1 level in the brain decreased slightly after 6 hours. These changes can be interpreted as follows: irradiation first causes abnormally high renal excretion of B_1 and increased consumption of B_1 by the tissues. These two factors lead to the low level of B_1 in the blood, which in turn causes an accelerated mobilization of B_1 from the liver to the blood. This is called exogenous B_1 deficiency. Endogenous B_1 deficiency, that is, disturbance of B_1 storage in the liver, occurs after 3 to 7 days. In either case, the liver is disturbed and is thus a rather decisive factor in the disturbance of B_1 metabolism. For the development of liver disturbance, direct irradiation of the liver is not always essential. The function of the CNS and its disturbance are also important factors in the development of impaired B_1 metabolism after irradiation. (auth)

21923 EFFECT OF ULTRAVIOLET INACTIVATION AND PHOTOREACTIVATION ON THE INDUCED SYNTHESIS OF β-GALACTOSIDASE BY ESCHERICHIA COLI. T. Kameyama and G. David Novelli (Oak Ridge National Lab., Tenn.). Arch. Biochem. Biophys., 97: 529-37(June 1962).

The inactivation of the synthesis of induced β-galactosidase by cells of Escherichia coli by ultraviolet irradiation is described. Synthesis of enzyme can be preferentially restored by photoreactivation. Examination of crude cell extracts by zone electrophoresis revealed the presence of a particle-bound enzyme that did not migrate in the electric field. The particle-bound enzyme is shown to exist only as long as inducer is present. The significance of these observations with respect to the possible mechanism of enzyme synthesis is discussed. (auth)

21924 EFFECT OF RADIATIONS ON HEART LACTIC DEHYDROGENASE AND PANCREAS RIBONUCLEASE AND PROTECTIVE ACTION OF A SULFANILAMIDE DISULFIDE. Luigi Brighenti and Arturo Falaschi (Univ. of Ferrara, Italy). Biochim. et Biophys. Acta, 59: 376-88(May 21, 1962). In English)

Solutions of heart lactic dehydrogenase and pancreas RNAase were strikingly inactivated by treatment with ultraviolet, x- and γ-radiations. A similar inactivation was obtained by treating heart lactic dehydrogenase with chemically produced free radicals. A new disulfide compound, namely bis(2-amino-4-sulfonamido-phenyl)disulfide, acted, when it was added to the enzymes in solution, as a protective agent both in irradiated enzymes and in those treated with free radicals. The evidence obtained points to the conclusion that the disulfide protects by trapping the inactivating free radicals produced by the radiation. (auth)

21925 ABSORPTION OF UV RADIATION IN THE GIANT NERVE FIBER OF THE CUTTLEFISH. L. P. Shmelev, L. P. Kayushin (Inst. of Biological Physics, Academy of Sciences, Moscow). Biophysics (U.S.S.R.) (English Translation), 6: No. 4, 40-2(1961).

An increase in the transparency of the giant nerve fiber to uv light of a wave length of 265 mμ during excitation may be caused by several factors. A change in absorption in this region of the spectrum is usually attributed to the content of nucleic acids (RNA). There are no reliable data which would show a noticeable content of nucleic acids in the giant axon. It is also difficult to believe that the peculiar properties of nucleic acids (protein synthesis) are necessary to bring about the hypothetical biochemical transformations during nerve stimulation. One may think that the change in the absorption spectrum at 265 mμ is governed by reactions in the acetylocholine system. However, according to the data presented, absorption increases

at 265 mμ during the interaction of acetylocholine with its enzyme. It is most probable that reactions in which the adenyl system participates play an important part in the process of excitation. The giant axon contains a large amount of adenosinetriphosphoric acid primarily in the nerve membrane. Even a small fluctuation of the medium may cause a marked change in the absorption of uv light at 265 mμ in the adenyl system. A direct deaminization of ADP is possible with the use of the energy of deamination for the transmission of the excitation. It has been mentioned earlier that the increase in absorption in the 280 mμ region of the spectrum is associated with the accumulation during the decomposition of protein molecules of free chromophoric groups, which selectively absorb uv radiation of a given wavelength. It must be noted that a similar phenomenon also takes place during the transmission of the excitation, which is of very short duration (~0.001 sec). (auth)

21926 A METHOD FOR CALCULATING THE ALPHA-RAY DOSAGE TO SOFT TISSUE-FILLED CAVITIES IN BONE. D. E. Charlton and D. V. Cormack (Univ. of Saskatchewan and Saskatoon Cancer Clinic, Can.). Brit. J. Radiol., 35: 473-7(July 1962).

A method for calculating the absorbed dose at points near a plane interface between the bone and soft tissue and in soft tissue-filled cavities, from an α-emitting source homogeneously distributed in bone, is presented. Geometrical factors for calculating the absorbed dose from radium α particles are given. The mean geometrical factors for various cylindrical cavities were determined and compared with those of Kononenko and Spiers. The absorbed doses to soft tissue-filled cavities calculated by this method are higher than the values of these authors. (auth)

21927 THE COMPUTATION OF DOSE DISTRIBUTIONS IN COBALT ROTATIONAL THERAPY. R. G. Wood (Cardiff Radiotherapy Centre, Whitchurch, Eng.). Brit. J. Radiol., 35: 482-4(July 1962).

An account is given of the application of a punched card electronic computer to the calculation of dose distributions in rotational cobalt therapy based on the use of an effective absorption coefficient to allow for varying patient thickness as described by Jones et al. (1956). (auth)

21928 DOSE, TIME AND VOLUME PARAMETERS IN IRRADIATION THERAPY OF KAPOSI'S SARCOMA. Lionel Cohen (Johannesburg Hospital). Brit. J. Radiol., 35: 485-8 (July 1962).

With the exception of those patients in whom the disease becomes widely disseminated, it appears that the lesions of Kaposi's sarcoma may be cured by radiation therapy provided that the quality, time, area and dosage factors are judiciously selected. A time-dose analysis indicates that the effective dose is of the order of 1,000 rads at a single exposure, and increases with fractionation by a factor of $T^{0.25}$, where T is the over-all time in days. The incidence of complications, mainly vascular and attributable at least in part to irradiation, approaches 25 per cent, and leads to ischaemic gangrene in 10 per cent, of patients treated radically without regard to the peculiar tolerance limits of extremities. It is estimated that, in treating extremities, a reduction in tissue dosage by about 40 per cent below that permissible in other areas is required, which necessitates prolonged fractionation (up to 2,500 rads in four weeks) for the larger portals. Taking the foregoing factors into account, it appears that a substantial proportion of patients could be cured in the sense that the disease may be permanently eradicated from the treated areas, without either high-dose complications or evidence of local, regional or distant recurrence. (auth)

21929 SOME OBSERVATIONS ON THE REPRODUCTIVE CAPACITY OF MAMMALIAN TUMOUR CELLS EXPOSED IN VIVO TO GAMMA RADIATION AT LOW DOSE-RATES. R. J. Berry and A. B. Cohen (National Cancer Inst., Bethesda, Md.). Brit. J. Radiol., 35: 489-91(July 1962).

Dose-response curves have been obtained for continuous γ irradiation of mammalian tumor cells in vivo under anoxic conditions at dose-rates approximating those used in clinical radium or Co^{60} implantations. The fraction of tumor cells remaining reproductively intact after various total doses of continuous irradiation was satisfactorily predicted from the dose-response to acute irradiation at high dose-rate by applying the mathematical model recently described in this journal by Lajtha and Oliver (1961). (auth)

21930 CHANGES IN HASSALL'S CORPUSCLES IN REGENERATION OF THE THYMUS AFTER EXPOSURE TO X-RAYS. D. G. Malkina (Voronezhskii Medical Inst., USSR). Bull. Expti. Biol. Med. (U.S.S.R.) (English Translation), 52: 1204-8(May 1962).

Morphological changes in Hassall's corpuscles were studied in guinea pigs during regeneration of the thymus after exposure to localized and general x irradiation. The structural changes observed were all destructive in nature. (C.H.)

21931 EFFECTS OF GAMMA RADIATION ON TWO DECAPOD CRUSTACEANS, PALAEMONETES PUGIO AND UCA PUGNAX. George H. Rees. Chesapeake Sci., 3: No. 1, 29-34(Mar. 1962).

Experiments are described that were undertaken with the objective of determining the lethal dosages of gamma radiation, particularly the doses at which 50% succumb (LD_{50}), for 2 decapod crustaceans. (Pub. Health Eng. Abstr.)

21932 ON THE SENSITIVITY OF TRIFOLIUM SEEDS TO GAMMA RADIATION. Gayther L. Plummer (Univ. of Georgia, Athens). Crop Sci., 2: 221-3(May-June 1962).

In no species-treatment group has any growth response of Trifolium been noticeably benefitted by 43- to 280-kr gamma irradiation. All the species showed obvious growth inhibition from 43 kr or more during the first 60 days. Later, certain undetermined recovery adjustments brought those plants from a seed-treatment group with 43 kr to near normal growth characteristics within 4 months. Many seeds exposed to 93 kr are capable of producing mature plants with apparently normal characteristics after 4 months of growth. Exposure to 140 kr is a severe treatment from which shoots will develop, but no favorable recovery can be expected. Shoots would not be expected to develop from seeds exposed to 280 kr. (auth)

21933 USE OF FILM DOSIMETRY FOR PROTECTION AGAINST DAMAGE BY IRRADIATION: REPORT OF CENTER MEASURING RADIATION EXPOSURE IN BERLIN IN 1959 AND 1960. H. Oeser, P. Koeppe, and K. Rach. Deut. med. Wochschr., 87: 181(Jan. 26, 1962).

Data are reported on exposure to radiation collected by the Center for Radiation Protection in West Berlin during 1959 and 1960. Film dosimetry was found to be a reliable method for this purpose. Excessive exposure of lay personnel was usually due to lack of knowledge, while exposure of professional personnel was usually due to lack of concern for the dangers of ionizing radiation. The authors emphasize that exposure should be avoided even though it is within the limits of permissible doses. (Pub. Health Eng. Abstr.)

21934 THE EFFECTS OF GAMMA RAY AND THERMAL NEUTRON IRRADIATION ON DORMANT FLAX SEEDS AS MEASURED BY OIL QUALITY AND SEED

YIELD. Dale Douglas Harpstead (Univ. of Nebraska, Lincoln). Dissertation Abstr., 22: 2551(Feb. 1962).

The effects of radiation on dormant flax seed were evaluated in the third and fourth generations after treatment by the measurement of three quantitatively inherited characters: iodine number, per cent oil in seeds, and yield of seed. Seed used for this study was obtained from single plant selections increased two generations under strict isolation. Two varieties of flax, Redwing and Bison, were used for the irradiation and control treatments. Seed samples of each variety received five different irradiation treatments. These treatments included three levels of gamma rays: 15,000, 30,000, and 45,000 roentgen units and two levels of thermal neutrons: 2.99×10^{13} and 4.69×10^{13} N_{th}/cm^2. A comparable seed sample was maintained as a control treatment. The initial generation after irradiation (R_1 generation) was grown in the greenhouse to reduce the possibility of natural crossing. Seeds from individually harvested plants of the R_1 generation were grown in the field the following season. The R_2 generation was sampled by harvesting individual, variant-type plants, together with randomly selected, normal-appearing plants from the same row. The R_3 generation was grown in the field in single row plots representing individual R_2 plants. Bulked seed from each row was grown in two replications at each of two locations in the R_4 generation. Remnant R_3 seed was evaluated for iodine number of the oil and per cent oil in seeds. Similar measurements were made on seed of the R_4 generation. Yields of these progenies were obtained. The statistical analyses of the data collected from the R_4 generation indicated that the variances associated with irradiated treatments were more frequently significant than those associated with controls. Estimates of heritability were determined by two methods. One method, based on the analysis of variance utilizing the components of variance, provided estimates for all three characters studied. The second method of estimating heritability was based on the correlation between measurements made on parent and offspring for iodine number and per cent oil in the R_3 and R_4 generations. The changes in iodine number induced in irradiated progenies of each variety were estimated to be highly heritable, while the heritability estimates in control progenies were essentially zero. The distribution of iodine values among irradiated progenies indicated that the range of values was extended in both directions following treatments. The variance associated with per cent oil in seeds was found to arise chiefly from non-heritable progeny x location interactions which lead to low heritability estimates. Furthermore, little agreement was found between heritability values calculated by the two methods used. The variance associated with yield resulted primarily from decreases in yield among a few irradiated progenies and from non-heritable interactions. On the basis of this study irradiation would appear to be an effective means of increasing genetic variability of iodine number. The heritabilities would indicate that successful selection for increased iodine number could be accomplished among irradiated progenies, but little progress could be expected by selection for increased oil percentage or increased yield. It is proposed that iodine number may be inherited in a less complex manner than oil percentage or seed yield and is more susceptible to modification by irradiation-induced genetic changes.

21935 THE EFFECT(S) OF X-IRRADIATION ON THE IMMUNITY OF MICE INFECTED WITH TRICHINELLA SPIRALIS. Allen Yarinsky (Univ. of North Carolina, Chapel Hill). Dissertation Abstr., 22: 2763-4(Feb. 1962).

This study was undertaken to determine the effects of whole body x-irradiation on the immunity of mice to Trichinella spiralis. Six experiments were performed. In Experiment I, various doses of irradiation (250 to 650 r), given 24 hr prior to various infections (50 to 200 T. spiralis), were tested for their lethal action. A significant mortality (about 60%) occurred among those given the highest dose of irradiation, and most of the deaths were noted between nine and thirteen days postirradiation. The maximum sublethal dose proved to be 450 r. In Experiment II, mice were irradiated with 50, 250, 450, or 650 r 24 hr prior to a single infection with 200 T. spiralis. No interference was noted in the development of acquired immunity as measured by adult counts at fourteen days, but interference with the maintenance was noted at 20 and 28 days in those exposed to 450 and 650 r. In those showing a normal immune response at the various periods, the body weights showed a pattern of striking weight loss and gain that appeared to be associated with the stresses of the intestinal inflammation thought to be responsible for the development and maintenance of this immunity. In Experiments III to VI, the mice were strongly immunized before being given the irradiation exposure. When this was given 24 hr prior to the challenge infection, in most cases there was no interference in the maintenance of the immunity by 7 days. Again, there was a striking weight loss at a time (4 to 6 days) when it is known that the intestinal inflammation reaches a zenith in previously immunized mice. Soon thereafter, only those showing a normal immune response at later periods showed gain in body weight. In those given the high doses (450 r, 650 r) interference with the immunity was evident at 14 days (one week earlier than in the above mice given only one infection). Recovery of the full immunity was evident within an additional two weeks. Similar results with a 650-r dose were obtained when the irradiation followed the challenge infection by 1, 2, or 3 days. Interference with the immunity was demonstrated at 7 days when the schedule of irradiation was altered so that the 7-day necropsy was equivalent to the 14 day period in the previous experiments. By so doing, the postirradiation period (15 days) was the same. The resulting absence of acquired immunity was accompanied by a striking loss of neutrophils and lymphocytes from the peripheral circulation. The immunity as measured at 7 days was also absent when the postirradiation time was 11 and 19 days, although in the latter case the interference appeared to be diminishing. By considering the results at the various postirradiation periods, the body weight data, and the total and differential white blood cell patterns a hypothesis was presented in an effort to explain the demonstrated interferences with the immunity. Hemagglutination test results obtained during the course of the 4 experiments involving previously immunized mice did not appear to reflect the immune status of the hosts. The larval worm recoveries from 3 of 4 experiments suggest that the majority of larvipositing was completed prior to the demonstrated interference with the host's immune response to the intestinal phase of the infection. The data from one of the experiments suggest that interference with the reproductive potential of the female worms and/or a serologic factor may be responsible for the reduction in the numbers of larvae recovered from the musculature.

21936 THE EFFECTS OF HORMONES AND X-IRRADIATION ON THE SURVIVAL OF ISOGRAFTED FETAL MOUSE HEARTS. Patrick Roland Wells (Univ. of Nebraska, Lincoln). Dissertation Abstr., 22: 2828-9(Feb. 1962).

Work concerned with the isografting of fetal mouse hearts and the effects of the recipient's sex, adrenocorticotrophic hormone, cortisone acetate topically and parenterally, and X-irradiation on the survival of these hearts is described. The fetal mouse hearts were obtained from mice of strain C3H/JAX in the final days of gestation. The hearts were removed using sterile technique and placed upon the exposed blood vessel under the (cellulose acetate-Saran) chamber on the recipient's back. The hearts were then observed by microscopic examination for viability of the tissue. The cardiac tissue was considered viable as long as pulsatile activity could be observed. Survival time was considered as the time from the day of transplantation to the day of cessation of pulsation and was recorded in days. The mean survival time for fetal cardiac tissue isografted on untreated male mice was 30.00 days. Statistical comparison was made of means employing the "F" test and the "t" test with a probability level of 5%. The sex of the recipient animal had no effect on the survival of isografted fetal tissue as demonstrated by a $P > 0.05$ on statistical comparison of means between male and female animals. However, castrated males showed a significant decrease in survival time which was not apparent in castrated females. Whether the significant decrease in survival shown by castrated males can be attributed to the absence of testosterone needs further elucidation. The irradiation of the host animal with 250 r of x rays 24 hr prior to transplantation showed no significant increase in survival time. A dosage of 400 r proved fatal to all mice submitted to this exposure. Adrenocorticotropic hormone likewise demonstrated little effect on survival time in the dosage employed. The action of ACTH on the adrenal cortex caused the production of the glucocorticoids and mineralocorticoids. The mineralocorticoids were prophlogistic in nature and probably accounted for the rejection of the isografted heart tissue. Intramuscular injections of cortisone acetate gave the most profound results. The mean survival time was 49.14 days and when statistically compared with untreated males a highly significant difference was revealed ($P < 0.001$). Histological studies of the graft bed show resorption occurring. It was concluded from these data that by employing genetically-related donors and subsequent cortisone therapy more prolonged survival of transplanted tissue may be assured.

21937 EFFECT OF WHOLE BODY IONIZING IRRADIATION ON IN VITRO ANAPHYLAXIS OF THE GUINEA PIG. Bernice Leagus (Pennsylvania State Univ., University Park). Dissertation Abstr., 22: 3816(May 1962).

The effect of a single LD_{50} dose of whole body ionizing radiation on the in vitro anaphylactic response of the guinea pig was investigated to establish a temporal relationship between administration of radiation and manifestation of the hypersensitive state. The study was extended to the serological analysis of sera and extracts of lymphoid tissue and to the effect of radiation on serum complement levels and total leucocyte counts. Irradiations were carried out with the facilities of the research reactor of The Pennsylvania State University. The dose of 200 roentgens provoked leucopenia but was not lethal. Crystalline egg albumin was used as the sensitizing antigen for active anaphylaxis and was administered intraperitoneally and intracardially in doses of 5 and 100 mg. Rabbit anti-EA antiserum containing 3 mg antibody nitrogen was used for passive sensitization. In vitro testing for the anaphylactic state was carried out 10 to 14 days after sensitization by the Schultz-Dale reaction, and serological testing was performed with the precipitin ring and complement fixation tests. Lymph node and spleen cell extracts were made by alternate freezing and thawing of cells freed from excised organs. Serum complement levels were determined by titration for the 50 per cent hemolytic unit. Route of antigen administration did not affect development of the anaphylactic state. Active anaphylaxis was suppressed when 5 mg EA was used for sensitization and when irradiation was carried out 1 hour and 1 and 2 days before sensitization. Irradiation 7, 2, and 1 day after and 3 days before sensitization did not alter the anaphylactic response. With 100 mg EA as the sensitizing dose, suppression of anaphylaxis was not as marked. Circulating antibody was not demonstrated in the sera of animals sensitized with 5 mg EA 1 day before and 1 hour, 1, 2, and 3 days after irradiation and in animals sensitized with 100 mg EA 3 days after irradiation. These data indicate that the inhibitory effect of radiation appears dependent upon radiation induced changes in the antibody synthesizing mechanism prior to administration of antigen. The significance of these data as they are related to the hypersensitive state is discussed with particular attention being given to the prolonged induction period and the concentration of the sensitizing antigen dose. Passive anaphylaxis and the level of serum complement were not altered by irradiation. No conclusions were drawn from the studies of the tissue extracts, since antibody was not detected in the lymphoid tissue of either the non-irradiated or irradiated sensitized animals.

21938 NUCLEAR DIFFERENTIATION IN TETRAHYMENA PYRIFORMIS AS AFFECTED BY NEAR INFRARED AND X-RADIATION. Margaret May Wells (Emory Univ., Atlanta). Dissertation Abstr., 22: 3824-5(May 1962).

The effects of near infrared, near infrared-x radiation, and x radiation on nuclear differentiation of Tetrahymena pyriformis were studied. Two strains of variety 1, one of mating type I and one of mating type II, were used. Near infrared exposures of 4, 6, 8, 16, and 24 hours to wavelengths of 7,000 to 13,000 Å were administered alone and as pretreatment for two separate doses of continuous x radiation. The x-ray doses of 150 and 300 kr were also used alone in studying radiation effects of Tetrahymena. Radiation was given only to mating type II vegetative animals in the log phase of growth. Following a 24-hr recovery period, experimental cultures were mixed with non-radiated mating type I animals and allowed to conjugate. Evaluation of the effects of the several types of radiation treatment was made at the anlagen stage of conjugation. A study of pre-anlagen stage conjugants was carried out to determine how the types of abnormalities observed in anlagen stage were formed. The immediate effects of all radiation treatments were studied in unfixed and unstained animals under a phase contrast microscope. A similarity in the morphological responses was observed in the living ciliates regardless of the type of radiation received. Anlagen abnormalities were scored in three ways for each treatment. The total number of abnormal anlagen pairs was compared to the total number of normal anlagen pairs. The different types of nuclear abnormalities within anlagen pairs were compared. The frequencies of anlagen pairs within three classes (A, B-1, and B-2) were compared. Class A consisted of anlagen pairs with no abnormalities, class B-1 contained those anlagen pairs with only one conjugant abnormal, and class B-2 contained anlagen pairs with abnormalities in both conjugants. Although near infrared radiation alone was ineffective in increasing the total number of abnormal pairs as determined at anlagen stage of conjugation, a significant difference in the frequency within the three classes of anlagen pairs was observed after a single exposure to infrared radiation. X radiation used alone in doses of 150

or 300 kr produced a substantial increase in the number of nuclear abnormalities observed. The frequency of anlagen pairs within the three classes was also significantly affected by both 150 and 300 kr x radiation. A potentiation of x-radiation damage was observed with near infrared pretreatment. The combined radiation produced a significant difference in the number of abnormal pairs produced and in the frequency within the three classes recovered at anlagen stage. None of the tested radiation treatments produced significantly different types of nuclear abnormalities as determined by examination of pre-anlagen conjugation stages. Anlagen stage of Tetrahymena conjugation was found to be an ideal stage for observing radiation effects on nuclear differentiation. Gomori's hematoxylin was an effective aid in distinguishing nuclear types of scoring abnormalities. Fluorescent microscopy of living animals stained with acridine orange was of incalculable value in determining the nuclear stage of experimental cultures. The implications of the observed effects of individual and combined radiations are discussed in the light of the mechanisms influencing nuclear differentiation in Tetrahymena .

21939 HISTOCHEMICAL REACTION WITH POLYSACCHARIDES IN STUDYING DISTURBANCES IN SPERMATOGENESIS. I. A. Chalisov and T. N. Khavkin (Kirov Military-Medical Academy, USSR). Doklady Akad. Nauk S.S.S.R., 143: 214-17(Mar. 1, 1962). (In Russian)

Guinea pigs were given a total x-ray dose of 3000 r in the pelvic region, and then were killed at 0.25, 0.5, 1, 2, 4, 6, 8, 11, 14, 18, 20, 25, 35, and 65 days after irradiation. Sections of the testes were fixed and stained with periodate-leucofuchsin. A determination of the cell associations in the seminal canals and a quantitative estimate of the spermatogenesis were carried out. The number of canals containing mature sperm decreased by a factor of two during the first week after irradiation. The staining technique showed up spermatids with two or more spheres and deviations in the formation of the achrosome and head of the sperm. The cell composition in various seminal canals varies significantly with the degree of maturity of the cell and the time elapsed after irradiation. (TTT).

21940 THE EFFECT OF SMALL DOSES OF IONIZING RADIATION AND OF CYSTAMINE ON THE MITOTIC ACTIVITY OF CORNEAL EPITHELIUM AND OF DUODENAL CRYPTS. L. B. Berlin (Kirov Military-Medical Academy, USSR). Doklady Akad. Nauk S.S.S.R., 143: 218-20(Mar. 1, 1962). (In Russian)

White rats (188 g in weight) were given a total Co^{60} dose of 65 r with and without the administration of 60 mg/kg body weight of the disulfide derivative of mercaptoethylamine. Mitoses were determined on plane sections of the cornea and of the duodenum which are two tissues that differ greatly in radiosensitivity. The normal mitoses are 150 in the summer and 87 in the winter for the cornea, and 108 for the duodenal tissue. The number of mitoses in the corneal tissue drops to 24 one hour after irradiation and then returns to normal within 20 hours after irradiation with a sharp increase in mitotic activity thereafter (149 to 189 dividing cells). The change in the number of mitoses in the duodenal tissue is less pronounced. The introduction of the mercaptoethylamine derivative did not substantially affect the mitotic activity observed in irradiated animals which had not been given a protective chemical compound. (TTT).

21941 THE EFFECT OF γ-RADIATION ON THE EXCHANGE OF NUCLEIC ACIDS IN THE FOOD RESERVES OF PLANTS. L. V. Metlitskii, N. P. Korableva, and N. P. Morozova (Bakh Inst. of Biochemistry, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 143: 225-7 (Mar. 1, 1962). (In Russian)

Two types of onion (Allium cera and Allium sativum), and potato tubers were subjected to doses of 5000 to 60,000 r. The changes in nucleic acid content in the embryonic and pulpy part of the plant were followed. A dose of 10,000 r to potato tubers results in a 50% decrease in the content of guanidine, adenine, cytidine, and uridine in the embryonic parts of the tissue. Observations show that the ordinary onion (Allium cera) is less resistant to radiation than the garlic (Allium sativum). A dose of 5000 r to the ordinary onion results in a 35% decrease in content of nucleic acids in the merismatic parts of the plant, while a dose of 60,000 r caused hardly any change in the garlic. After 6 months storage there is a rise of 30 to 40% in nucleic acid content of the onion and potato bulbs, but the increase in nucleic acid content is much greater for the unirradiated bulbs. The retarding effect of γ-irradiation on the growth of plants is caused by a disturbance in the nucleic acid exchange. (TTT).

21942 THE FREQUENCY-DOSE RELATION OF X-RAY-INDUCED Y-SUPPRESSED LETHALS IN DROSOPHILA. C. W. Edington, J. L. Epler, and J. D. Regen (Florida State Univ., Tallahassee). Genetics, 47: 397-406 (Apr. 1962).

An investigation was made to determine the frequency-dose relations of total sex-linked recessive lethals as measured by the S-5 technique and the two major classes of lethals, orthodox and Y-suppressed, of which they are composed. It was found that orthodox lethals increase linearly with increasing dose. Y-suppressed lethals, which behave for the most part as V-type position effects and constitute a large fraction (83% at 1082r–17.3% at 4328r) of total lethals at all doses studied, increase more rapidly than expected on the basis of linearity. When orthodox and Y-suppressed lethals were combined, it was shown that the frequency-dose relation of total lethals deviated significantly from linearity. The significance of these dose-response relationships to recessive lethal origin has been discussed. (auth)

21943 SUPERVITAL MUTANTS OF ARABIDOPSIS. Gyoergy P. Rédei (Univ. of Missouri, Columbia). Genetics, 47: 443-60(Apr. 1962).

At three loci four phenotypically different mutations were induced by x rays which affect the photoperiodic response of the carrier. The standard wild type develops visible flower primordia in 10 to 12 days after germination. The mutants have various flowering response and may need a period up to 4 to 6 times as long for the completion of the same developmental stage. In spite of the large differences in the time required for the onset of flowering, the life cycle of the latest mutant is only 2 to 3 times that of the wild type. The slower development is accompanied by very vigorous growth; dry matter production may increase over 20 times and seed production may rise tenfold. These hereditary changes do not involve impaired genetic transmission, altered crossing-over value or visible chromosomal alterations. In three different competitive populations (mutant × wild) under long-day conditions, in the greenhouse, during a 60-week period (about ten generations of the wild type), the mutant allele increased from the initial 0.500 frequency to 0.869, 0.995, and 0.997, respectively. The roughly estimated selective advantage of the mutants under the experimental conditions varies from 0.3 to over 1.0. These are extremely high values. Since the progress of selection is rapid in a self-fertilizing plant community,

if vigorous late mutants occur at a fair rate, their rapid increase may be expected. In nature late ecotypes are prevalent. The possible evolution of the photoperiodic response in the species is discussed. The suggestion is made that the different degree of dominance of the late ecotypes, based on modifier genes, indicates the evolution of dominance of the character concerned and the late flowering forms in nature represent the emergence of the new wild type of the species. (auth)

21944 THE GENUS COLLINSIA. XVII. A CYTOGENETIC STUDY OF RADIATION-INDUCED RECIPROCAL TRANSLOCATIONS IN C. HETEROPHYLLA. E. D. Garber and T. S. Dhillon (Univ. of Chicago). Genetics, 47: 461-7 (Apr. 1962).

Four reciprocal translocations involving two nonhomologous chromosomes and one involving three nonhomologous chromosomes were obtained either from plants of Collinsia heterophylla (n = 7) at the prebud stage or from seed which has been exposed to ionizing radiation from an x-ray source or from a cobalt therapy unit. The interchange complexes occurred either as a ring or chain but rarely as bivalents at metaphase I; the rings and chains displayed a directed orientation at this stage. Although the percentage of stainable pollen grains and the number of seed per capsule were reduced in plants with an interchange complex, the plants were not semisterile; plants with an interchange complex of six chromosomes had a lower-set than plants with an interchange complex of four chromosomes. Five of the seven chromosomes in the complement are involved in the five reciprocal translocations. The gene for white flower is linked with two different reciprocal translocations which have one chromosome in common. The chromosomes of this species are assumed to have a terminal or subterminal chiasma-forming segment in each arm. To account for the different types of interchange complex obtained after colchicine treatment or exposure to ionizing radiation, it is assumed that the former treatment is responsible for chromosome breaks in the chiasma-forming segments and the latter for breaks in the segment of the chromosome proximal to the centromere. (auth)

21945 BACK MUTATION IN DROSOPHILA MELANOGASTER. II. DATA ON ADDITIONAL YELLOW AND WHITE MUTANTS. M. M. Green (Univ. of California, Davis). Genetics, 47: 483-8(Apr. 1962).

Further attempts to obtain x-ray-induced mutations at the yellow and white loci in Drosophila melanogaster are reported. Of five independent white mutants tested, only w^{bf} yielded back mutants. Of the five yellow mutants studied, a single apparent reversal of the x-ray-induced mutant y^{50k} was found. The relationship of these data to previously reported back mutation data in Drosophila are discussed. (auth)

21946 STUDY ON THE TREATMENT OF MALIGNANT TUMOURS WITH COLLOIDAL RADIO-ISOTOPES. (ENGLISH TEXT). Y. Namba (Hiroshima Univ. School of Medicine, Japan). Hiroshima J. Med. Sci., 9: No. 1, 45-53 (1960).

Colloidal Au^{198} and $CrP^{32}O_4$ suspension were injected into the abdomen of white rats with Yoshida's sarcoma and their inhibitive action on the development of sarcoma cells was studied. Following injection of these isotopes, the liver showed vascular degeneration, dissolution of the liver cells and disappearance of the nucleolus; this was more evident with $CrP^{32}O_4$ than with Au^{198}. The spleen showed hemorrhage in the medulla. The small intestine showed swelling and disappearance of cell nuclei and vacuolar degeneration of the cytoplasm. The ovary showed a tendency to destruction of the granular cells. The changes in the kidney and pancreas were slight. Clinically, gynecologic malignant tumor cases, 11 in number, were treated with Au^{198}, 3 of them being also treated with $CrP^{32}O_4$. While there was at any rate a hope to prolong their lives, no effect of cure was noted. (auth)

21947 EFFECT OF RADIATION ON BIOLOGICAL SYSTEMS. II. PHYSIOLOGICAL REACTIONS. P.-E. Pilet (Université, Lausanne, Switzerland). Inds. atomiques, 6: No. 1-2, 59-69(1962). (In French)

The results, principally macroscopic, of the application of radiation on living tissues are examined, and some of the most characteristic physiological reactions are examined. The physiological processes considered are cell localization, permeability, respiration, enzymatic activity, and metabolism. (J.S.R.)

21948 CELL DIVISION IN A SPECIES OF ERWINIA. III. REVERSAL OF INHIBITION OF CELL DIVISION CAUSED BY D-AMINO ACIDS, PENICILLIN, AND ULTRAVIOLET LIGHT. E. A. Grula and Mary M. Grula (Oklahoma State Univ., Stillwater, Okla.). J. Bacteriol., 83: 981-8(May 1962).

Inhibition of cell division in an Erwinia sp. occurs in the presence of any of six D-amino acids, penicillin, or ultraviolet light. Cell-division inhibition caused by D-amino acids is pH-dependent; however, elongation caused by penicillin occurs over a wide range of pH. Bulging and spheroplast formation in the presence of penicillin occurs only at pH values below 7.6; however, division continues to be inhibited at higher pH levels. Reversal of cell-division inhibition caused by two D-amino acids (phenylalanine and histidine) can be partially overcome by their respective L-isomers. Divalent cations (Zn, Ca, Mn) cause varying amounts of reversal of division inhibition in all systems studied; each system appears to have an individual requirement. All induced division inhibitions, including that caused by penicillin, can be reversed by pantoyl lactone or ω-methylpantoyl lactone. Evidence is presented and discussed concerning the possible importance of pantoyl lactone and divalent cations in terminal steps of the cell-division process in this organism. (auth)

21949 EFFECTS OF NEAR-ULTRAVIOLET IRRADIATION ON GROWTH AND OXIDATIVE METABOLISM OF BACTERIA. E. R. Kashket and A. F. Brodie (Harvard Medical School, Boston). J. Bacteriol., 83: 1094-1100 (May 1962).

The effects of irradiation with near-ultraviolet light (360 mμ) have been studied with Escherichia coli W and a strain of Pseudomonas aeruginosa. The growth of the aerobe P. aeruginosa was inhibited by light on minimal salts media containing succinate, glutamate, or glucose as sole carbon sources. The facultative anaerobe E. coli was capable of growth under irradiation on a fermentable carbon source, such as glucose, but with a smaller yield of cells on limiting substrate, as compared to unirradiated control cultures. The rate of growth of aerobic irradiated cells on glucose was equal to that of anaerobic growth on that carbon source, and there was a greater accumulation of end products of glucose catabolism aerobically in the light as compared to dark controls. When irradiated in media containing carbon sources from which energy was obtainable only by oxidative phosphorylation, such as succinate or malate, E. coli cells were still capable of oxidizing these substrates but could not grow on them. This bacteriostatic effect of 360-mμ light could be reversed by the addition of glucose, which resulted in the growth of irradiated cells. Visible (400 to 600 mμ) light was found to have no effect. Irradiated E. coli

cells in succinate were found to contain no naphtho- or benzoquinones, compounds which are more sensitive to 360-mμ irradiation than other components of the respiratory chain. It is suggested that the effect of 360-mμ light on whole cells is the destruction of light-sensitive components, such as the benzoquinone Q_8 and naphthoquinone K_2C_{45} of E. coli W, which are essential for obtaining energy from oxidative metabolism. (auth)

21950 EFFECTS OF RADIOCOBALT IRRADIATION OF PREGNANT HAMSTERS ON THE DEVELOPMENT OF EMBRYOS. E. B. Harvey and M. C. Chang (Worcester Foundation for Experimental Biology, Shrewsbury, Mass.). J. Cellular Comp. Physiol., 59: 293-300(June 1962).

Pregnant hamsters from day 0.5 to day 12.5 were irradiated at 200 r from a radiocobalt source and a total of 834 fetuses were examined on day 13.5. This study showed that irradiation during cleavage stages induced subsequent mortality without a specific pattern of abnormality; during stages of active differentiation, high mortality with various head abnormalities; during organogenesis induced peripheral abnormalities with low mortality. (auth)

21951 STUDY OF THE MECHANISM OF INNATE RESISTANCE TO VIRUS INFECTION. Gail Theis Goodman and Hilary Koprowski (Wistar Inst. of Anatomy and Biology, Philadelphia). J. Cellular Comp. Physiol., 59: 333-73 (June 1962).

The concept of genetically-determined natural resistance was explored in two mouse strains of different genetic origin exposed to West Nile encephalitis virus and yellow fever virus. The inheritance of virus resistance was studied by the cross-breeding of virus-resistant male mice with virus-susceptible mice of the other strain. Data are tabulated and results are discussed. The mechanism of natural resistance appeared to be expressed at the cellular level in a cell type described as the macrophage. (C.H.)

21952 EFFECT OF LOCAL X-IRRADIATION ON THE PHAGOCYTE ABILITY OF LEUCOCYTES. R. Saito (Ministry of Welfare, Tokyo). J. Ind. Med. (Japan), 2: No. 2, 148(1960).

The whole body, the upper half of the trunk, or 4 legs only were irradiated in rabbits with 100 r. While the effect on the WBC was the most severe in the group totally irradiated, the other groups showed no change. A considerable decrease in the phagocytic ability of the neutrophil leukocytes resulted. This effect decreased in the order of whole body, upper body, and 4 legs' irradiation. The phagocytic ability seemed to show less individual variation and was more sensitive to radiation than the change in the RBC or WBC. (auth)

21953 SOME LATE EFFECTS OF RADIOSTRONTIUM IN RF MALE MICE. G. E. Cosgrove and A. C. Upton (Oak Ridge National Lab., Tenn.). J. Nuclear Med., 3: 293-9 (July 1962).

Young adult RF male mice were injected intravenously with radioactive strontium as follows: Group I, 0.2 μc Sr^{90}/g after splenectomy; Group II, 0.2 μc Sr^{90}/g after sham splenectomy; Group III, 0.51 μc Sr^{89}/g; Group IV, 0.04 μc Sr^{90}/g; and Group V, uninjected controls. After injection, the mice were observed until death, and effects on the life span and incidence of neoplastic and nonneoplastic diseases were studied. A dose of 0.2 μc Sr^{90}/g, with or without splenectomy, increased the incidence of thymic lymphosarcoma but did not detectably alter the incidence of myeloid leukemia. Other leukemias and lymphomas were also increased in number and occurred earlier. Two malignant bone tumors were found in 102 animals receiving 0.2 μc Sr^{90}/g, and one in 75 animals receiving 0.04 μc Sr^{90}/g, while none were noted in controls or in animals receiving 0.51 μc Sr^{89}/g. Effects on the life span were variable and of equivocal biological significance. (auth)

21954 SENSITIVITY OF SPATHIDIUM SPATHULA TO LOW DOSES OF X-RADIATION. Donald B. Williams (Oak Ridge National Lab., Tenn. and Vassar Coll., Poughkeepsie, N. Y.). J. Protozool., 9: 119-22(May 1962).

When Spathidium spathula was exposed to x ray doses ranging from 1 to 25 kr this animal was found to be more radiosensitive than any ciliate previously reported. A dose of 1 kr is sufficient to increase the time of the first generation from 5 to about 5½ hours. A dose of 4 kr is enough to approximately double the generation time. Bacteria in the medium during irradiation do not protect the ciliate against injury. Animals irradiated as dry cysts are only slightly more resistant than vegetative forms, requiring 10 kr to double the generation time. One day after exposure, irradiated lines are uniformly poor in growth rate, but later a bimodal response is noticed, some lines remaining poor and others recovering. Within 24 hours after treatment, a number of irradiated animals show structural abnormalities, and are greatly increased in size. The experiments have not determined the reason for the high sensitivity of Spathidium but have made certain alternatives unlikely. (auth)

21955 BIOCHEMICAL STUDIES ON IRRADIATED PROTOZOA. I. EFFECT OF METABOLITES ON THE RESPIRATION OF X-IRRADIATED TETRAHYMENA PYRIFORMIS. J. S. Roth (Univ. of Connecticut, Storrs and Marine Biological Lab., Woods Hole, Mass.). J. Protozool., 9: 142-6(May 1962).

When Tetrahymena suspended in water were given increasing doses of radiation, oxygen consumption decreased with increasing dose, reaching 60 to 90% at 600,000 r. Cells irradiated in 0.07 M phosphate buffer, pH 7.4, showed no significant decrease in oxygen consumption even at 600,000 r. The decrease in respiration observed on irradiation of Tetrahymena pyriformis W in water with 300,000 r of x radiation was prevented by addition of pyruvate or acetate during or immediately after irradiation. Pyruvate stimulated the respiration of the x-irradiated cells, particularly at 10 and 60 min post-irradiation. Lactate markedly stimulated the respiration of control suspensions of Tetrahymena cells and oxidation of lactate by cells irradiated with 300,000 r was increased by 20 to 100%, depending on the concentration of lactate and the time after irradiation. Pyruvate was considerably more effective than lactate in increasing O_2 uptake of x-irradiated cells, particularly at 10 min post-irradiation. Thioctic acid affected neither the respiration of control nor x-irradiated Tetrahymena nor the oxidation of pyruvate. The growth lag of Tetrahymena increased proportionately with increasing radiation dose; no cells survived 600,000 r. The presence of metabolites during irradiation did not affect the lag period or subsequent growth rates. The effects observed were discussed in terms of an alteration of the permeability of Tetrahymena after irradiation. (auth)

21956 LIMITS OF TRANSPLANTATION TOLERANCE IN LARGE AMOEBAE. I. MICROFUSION STUDIES USING AMOEBA PROTEUS, PELOMYXA ILLINOISENSIS, AND THREE STRAINS OF PELOMYXA CAROLINENSIS. E. W. Daniels (Argonne National Lab., Ill.). J. Protozool., 9: 183-7(May 1962).

Protoplasm transferred to a multinucleated amoeba is well tolerated if the donor and recipient portions are from the same amoeba, from different amoebae of a single clone,

from different amoebae of the same species found in a given location, or from different amoebae of the same species found in widely separated geographic areas. On the other hand, protoplasm is not tolerated and death invariably follows interspecific or intergeneric microtransfers between any two of the three species of amoebae used in this study. Attempts to overcome the tolerance block in heterologous transfers by the use of x radiation failed although a significant extension of the mean survival time was obtained. The latter can also be interpreted as a limited therapeutic effect of nonirradiated, heterologous donor protoplasm on supralethally irradiated recipients. (auth)

21957 EFFECT OF γ-IRRADIATION ON THE DIGESTIVE ORGANS. II. INFLUENCE OF γ-IRRADIATION TO THE INTESTINES ON THE MORTALITY OF RATS. H. Takayama (Osaka Univ. Medical School). Med. J. Osaka Univ. (Engl. Ed.), 11: 2481(1959).

Rats exposed to whole-body Co^{60} γ-irradiation of 1,000 r showed 100% mortality. When the intestines were protected from radiation, the animals tolerated radiations of 2,000 r relatively well. The LD_{100} was estimated as about 2,500 r in this case. When rats received radiations over the intestinal region only, the LD_{100} was about 1,500 r. Therefore, irradiation of the intestinal region seems to play a significant role in the mortality rate of animals. Irradiation of the reproductive and hematopoietic organs was not directly correlated with the mortality rate. (auth)

21958 CHEMICAL PROTECTION AGAINST ALPHA-PARTICLE IRRADIATION. Tikvah Alper (Medical Research Council, London), D. K. Bewley, and J. F. Fowler. Nature, 194: 1245-7(June 30, 1962).

Experiments were made on the ability of glycerol and cysteine to protect cells of E. coli B/r against 27- and 5.2-Mev α particles. Both chemicals were found to be protective, and the results are discussed with respect to possible protection mechanisms. It is concluded that the protection of bacteria by these two chemicals has a common mechanism different from any proposed mechanisms. (D.L.C.)

21959 EFFECT OF PRETREATMENT WITH NITRIC OXIDE AND N-ETHYLMALEIMIDE ON THE LEVEL OF SULPHYDRYL COMPOUNDS IN BACTERIA AND ON THEIR SENSITIVITY TO X-IRRADIATION UNDER ANOXIA. John P. Lynch and P. Howard-Flanders (Yale Univ. School of Medicine, New Haven). Nature, 194: 1247-9(June 30, 1962).

Shigella sonnei cells were exposed to nitric oxide of N-ethylmaleimide, the sulphydryl content of the treated bacteria was determined, and the bacteria were irradiated with x rays. The nitric oxide or N-ethylmaleimide treatment was found to decrease the sulphydryl content and the protective effect of anoxia against radiation in the bacteria cells. Cysteine was found to increase the protective effect of anoxia slightly for untreated cells. Reasons are given for believing the decrease in axonic protection to be due to the reduction of the intracellular sulphydryl compounds. (D.L.C.)

21960 STERILIZATION OF THE CODLING MOTH BY GAMMA-IRRADIATION. M. D. Proverbs (Canada Dept. of Agriculture, Summerland, B. C.). Nature, 194: 1297(June 30, 1962).

Studies were made to determine the feasibility of the sterile male technique as a means of eradicating the codling moth. When male pupae within 1 day of adult emergence and 12- to 24-hr old male moths were exposed to 40,000 rad γ rays, dominant lethals were induced in ~99% of the sperm without undesirable side effects. The female was more susceptible to γ irradiation than the male. Sperms from irradiated males competed rather poorly with those from normal males, but tests indicate that irradiation of a major fraction of the population may be a promising method for control of the codling moth. (D.L.C.)

21961 THE STRUCTURE OF FIBRIN CLOTS AFTER X IRRADIATION OF BLOOD PLASMA. E. Kühnke and G. Brilla (Universität, Bonn). Naturwissenschaften, 49: 163(1962). (In German)

Factors effecting the polymerization of fibrin are briefly reviewed, and it is shown that a preliminary x irradiation modifies the polymerization and therefore the clot structure. In order to determine whether the dependency between clot structure and pH is also present in irradiated plasma, blood plasma was irradiated at different pH values. The results show that at a given pH the clot transparency in the irradiated samples is much larger than in unirradiated samples. The reasons for the variation in the optical density of the clots were studied and possible solutions were suggested. (J.S.R.)

21962 OXALATE ELIMINATION IN THE URINE OF RADIATION INJURED MICE. Johannes Pany (Universität, Vienna). Naturwissenschaften, 49: 264(1962). (In German)

The assumption that a radioinduced perturbation of the vitamin B_6 utilization in the organism of the mouse can lead to an increased occurrence of oxalate in the urine was investigated. Mice of both sexes weighing 20 to 25 g were irradiated after fourteen days on a liquid diet. Daily food consumption, animal weight, and urine production were measured and the oxalic acid in the urine was determined. The values obtained for irradiated and nonirradiated animals are tabulated. The results show sharp fluctuations in the daily production of urine in the irradiated animal and a significant decrease of the oxalic acid eliminated daily. The oxalic acid concentration decreased with development of radiation sickness. (J.S.R.)

21963 STUDIES ON THE EFFECTS OF RADIATION AND VARIOUS CHEMICALS UPON THE ELECTROKINETIC POTENTIAL OF SARCOMA CELLS. K. Aoki (Hokkaido Univ. School of Medicine, Sapporo). Nippon Igaku Hoshasen Gakkai Zasshi, 20: 964-71(1960).

The electrokinetic potentials for 5 types of sarcoma were compared by converting their speed in electrophoresis into mobility values. The effects of various chemicals and x rays upon the mobility of MTK sarcoma II and Yoshida sarcoma cells were investigated. X irradiation temporarily depressed the mobility of MTK III and Yoshida sarcoma cells, but not to an equal degree. The changes of mobility caused by various chemicals and x rays corresponded in general with the changes in mitotic frequency caused by the same chemicals and x rays. (auth)

21964 EFFECT OF WHOLE-BODY X-IRRADIATION ON SERUM PROTEIN OF RABBITS (EFFECT OF WHOLE BODY X-IRRADIATION AT ONE TIME). S. Yoshino (Juntendo Univ. School of Medicine, Tokyo). Nippon Igaku Hoshasen Gakkai Zasshi, 20: 1330-44(1960)

The various fractions of the serum proteins of x-irradiated rabbits were measured by the paper-electrophoretic method. After 400 r whole-body irradiation, total protein and albumin were decreased, while α_1-, α_2- and γ-globulins were increased. After 1,000 r whole-body irradiation, total protein, albumin, and γ-globulin were decreased with an increase of α_1-, α_2- and β-globulins. After 400 r or 1,000 r whole-body irradiation, the lipoprotein index (β/α) was increased. After 200 r × 5 (every other day), total protein, albumin, and γ-globulin were de-

creased, while the α_1-, α_2- and β-globulins were increased. (auth)

21965 STUDIES ON THE EFFECT OF X-IRRADIATION UPON THE FUNCTION AND HISTOLOGICAL PICTURE OF THE THYROID GLAND USING I^{131}. I. Konno (Iwate Medical Coll., Morioka, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 20: 1924-43(1960).

I^{131} was administered to rabbits after x-irradiation of 4,000 r or 500 r to the thyroid region. When the thyroid function was activated with thyrotropic hormone the I^{131} uptake after x-irradiation was decreased markedly in comparison to the group not receiving hormone prior to x-irradiation. When the thyroid function was depressed with cortisone administration, the I^{131} uptake after x-irradiation was not so conspicuous as in cases without cortisone. The changes in the thyroid tissue were studied by means of micro-autoradiography. It was concluded that the thyroid function was easily affected by x-irradiation; histological examination revealed no very obvious changes. (auth)

21966 THE EFFECT OF VARIOUS RADIATION PROTECTION MATERIALS ON THE RADIOSENSITIVITY OF TUMORS. R. Koch (Universität, Freiburg i B.). Nuclear-Med., 2: 265-71(1962). (In German)

The influence of the agents cysteamine, serotonin, nicotinamide, thiourea, d-penicillinamine, and 5-mercaptopyridoxine on the radiosensitivity of tumor tissue in vitro and in vivo is tested. The investigations were with the mouse tumors Ehrlich ascites, solid Ehrlich carcinoma, and Crocker sarcoma 180. In the case of Ehrlich ascites only cysteamine, serotonine, and nicotinamide are able to protect the ascites cells. If solid Ehrlich carcinoma is irradiated in vivo, a significant protective action of cysteamine, serotonin, d-penicillamine, and 5-mercaptopyridoxine could be shown. In the same experiments with Crocker sarcoma none of the investigated substances are able to protect the in vivo irradiated tumor. (auth)

21967 THE QUESTION OF RADIATION PROTECTION WITH NICOTINAMIDE. R. Koch and S. Klemm (Universität, Freiburg i B.). Nuclear-Med., 2: 272-6(1962). (In German)

Nicotinamide has a radiation protective action for Ehrlich ascite cells, but none in the case of whole-body irradiated mice. The protective action for ascite cells is not only for the growing of the cells, but also for the anaerobic glycolysis and the stationary concentration of DPN. Both of the last mechanisms are much more radioresistant than the transplantability of the tumor. Therefore the protective action of the latter cannot be explained by a protection of the glycolysis or the DPN-content of the cells. (auth)

21968 EXPERIMENTAL STUDY ON THERAPEUTIC APPLICATION OF RADIOACTIVE COLLOIDAL SUBSTANCES. T. Miyauchi (Osaka City Univ. Medical School). Osaka Shiritsu Daigaku Igaku Zasshi, 9: No. 10, Suppl. No. 3, 3609(1960).

The internal distribution of colloidal Au^{198}, $CrP^{32}O_4$, and $Lu^{179}Cl_3$ in mice and rabbits by various administration methods was surveyed, and the possibility of clinical application of those radiocolloids is suggested. Up to 90% of the administered Au^{198} was concentrated in the liver when intravenously injected. $Lu^{179}Cl_3$ was readily absorbed when the serum solution was injected intramuscularly. The intravenous administration of $CrP^{32}O_4$ was most effective for liver irradiation. When $CrP^{32}O_4$ was injected intraperitoneally, only a few per cent was concentrated in the liver. (auth)

21969 DIFFUSION DISTANCE OF THE RADICALS PRODUCED BY IONIZING RADIATIONS IN CELLS. S. B. Bhattacharjee and N. N. Das Gupta (Saha Inst. of Nuclear Physics, Calcutta). Radiation Research, 16: 773-82(June 1962).

An analytical expression has been developed for the inactivation of cylindrical target molecules by the action of radicals formed in the surrounding medium by ionizing rays. This theory has been applied for the analysis of direct and indirect action of radiation on E. coli, yeast, and transforming principle in Pneumococcus. The average value of the ratio of the radius of the target molecule to the diffusion distance is 1.3. With unimolecular DNA as target, r_0 = 10 A, and ρ = 8 A. Indirect determination of ρ from diffusion constant and life of the radical gives a value of $r_0 \approx 20$ A. This value of r_0 leads to the conclusion that the inactivation process involves a target consisting of a bundle of DNA molecules. (auth)

21970 FIELD EQUATIONS IN DOSIMETRY. Harald H. Rossi and William C. Roesch (Columbia Univ., New York and General Electric Co., Richland, Wash.). Radiation Research, 16: 783-95(June 1962).

Field equations are presented for the solution of physical problems in radiation dosimetry. The equations describe the average behavior of radiation, many of the quantities to be defined are subject to statistical fluctuations due to the quantum nature of both radiation and matter. Illustrative applications of the equations are included. (C.H.)

21971 THE EFFECT OF DOSE RATE ON MODE OF ACUTE RADIATION DEATH OF C57BL AND BALB/c MICE. Robert F. Kallman (Stanford Univ. School of Medicine, Palo Alto, Calif.). Radiation Research, 16: 796-810 (June 1962).

Mature mice of two inbred strains, BALB/c and C57BL, were subjected to whole-body irradiation to determine the $LD_{50(30)}$. The LD_{50} increased with decreasing dose rate when the dose rate was approximately 5 r/min or less. For each dose rate, survival times were analyzed according to isolethality groups by pooling the survival times of decedent mice. Deaths fell in either of two ranges, intermediate and absolute, according to the expected LD calculated for the original exposure dose group. Mice irradiated at approximately 5 r/min and/or less died later than those irradiated at approximately 18 r/min. This was most pronounced in the C57BL strain at the absolute isolethal level. BALB/c mice showed only a slight tendency toward this effect, and this has been attributed to a greater dependence of death on marrow injury in this strain. It is concluded that the prolongation in survival time found for the lower dose rates reflects greater or more rapid recovery in the intestinal crypt cells than in the bone marrow cells. The concept of differential recoverability from radiation injury is discussed. (auth)

21972 THE SENSITIVITY OF CELLS FROM NORMAL MOUSE BONE MARROW TO GAMMA RADIATION IN VITRO AND IN VIVO. E. A. McCulloch and J. E. Till (Univ. of Toronto and Ontario Cancer Inst.). Radiation Research, 16: 822-32(June 1962).

A survival curve for the colony-forming ability of mouse bone marrow cells irradiated in vivo with Co^{60} γ-rays was obtained. The curve may be characterized by a D_0 of 95 rads and an extrapolation number of 1.5. Comparison with the survival curve obtained for cells irradiated in vitro indicated a statistically significant difference in extrapolation number. Possible explanations for this finding are considered. (auth)

21973 PATHOLOGICAL STUDY OF ORAL RADIATION DEATH IN MICE. Robert Goepp and Frank Fitch (Argonne Cancer Research Hospital, Chicago and Univ. of Chicago). Radiation Research, 16: 833-45(June 1962).

Male C57BL/6 mice were given x irradiation to various areas of the head. Irradiation of the entire head with 2000 r, or of the lower jaw and tongue with 4000 r, resulted in 100% mortality. Survival time after fatal head irradiation averaged 9 days, after fatal irradiation of the tongue and lower jaw, 11 days. Irradiation of other areas of the head with these amounts of x irradiation was not fatal. Histologic damage to the posterior surface of the tongue and of the soft palate is evident beginning 5 days after irradiation. The extent of ulceration was greater when the entire head was irradiated. Atrophy of the lymphoid tissue and other organs became marked shortly before death. Fluid intake and urine output decreased after the fifth postirradiation day and was accompanied by a marked, rapid weight loss which averaged 39% at the time of death. Gross and microscopic changes and similar weight loss were found in unirradiated mice dying after deprivation of food and water. Dehydration and starvation appear to be important lethal factors in mice dying 9 to 11 days after irradiation of the head with doses of 2000 to 4000 r. This process apparently starts about the fifth day after irradiation at a time when morphologic changes are present in the tongue. The mucosal damage, progressing to ulceration, appears to interfere with the ingestion and swallowing of food and water. (auth)

21974 THE DIRECT EFFECT OF X-IRRADIATION ON HeLa S3 DEOXYRIBONUCLEIC ACID SYNTHESIS. Robert B. Painter (Battelle Memorial Inst., Columbus, Ohio). Radiation Research, 16: 846-59(June 1962).

In HeLa S3 cell cultures, after x irradiation, there is an immediate depression of the rate of DNA synthesis, as measured by the incorporation of labeled nucleosides into the nucleic acids. There is no similar depression in RNA synthesis or incorporation of the tracer into the soluble pool, so that phosphorylation reactions do not seem to be the radiation-affected site. The extent of the inhibition of rate of DNA synthesis is dose-dependent, and the dose-response curve appears to be a two-component one. A tentative hypothesis has been made that the steeper (radiosensitive) component is due to an effect on primer, predominantly of cells in DNA synthesis at the time of irradiation, and the less steep (radioresistant) component is due to an effect on the polymerase-forming system, predominantly of cells in the pre-DNA synthesis (G_1) phase during irradiation. The effect of radiation on suppression of rate of DNA synthesis varies to a considerable extent from experiment to experiment and to a lesser extent from culture to culture. The basis of this variability is unknown but appears to depend to a great extent on the DNA metabolic activity of the individual cultures at the time of irradiation. Rapidly synthesizing cultures are most inhibited by irradiation, but very poorly metabolizing ones also contribute to the variability, simply because of their initial slower rate of DNA synthesis. Good correlation between specific-activity results and grain-count results has been obtained, but only by using the average values of grain counts over several control and irradiated cultures, because of the large variation among individual cultures. The immediate effect on the rate of DNA synthesis is great enough to explain our previous observations of increased percentages of cells in DNA synthesis (S retention) after 500 r of irradiation. Since the cells require a longer time to accomplish chromosomal replication, but the rate of entry of cells from G_1 into the DNA synthesis phase is undiminished, a pile-up of cells in DNA synthesis phase results. (auth)

21975 COMPARISON OF THE EFFECTS OF WHOLE-BODY X-IRRADIATION AND FASTING ON THE PLASMA LIPIDS OF MICE. Carl S. Rehnborg, James K. Ashikawa, and Alexander V. Nichols (Univ. of California, Berkeley). Radiation Research, 16: 860-6(June 1962).

Blood lipid changes in mice subjected to whole-body irradiation were investigated. Fatty acid distributions were determined by gas chromatographic techniques. The low-density lipoproteins (LDL) showed a significant drop in plasma concentration after irradiation. Alterations in fatty acid distribution in total plasma may be due to the LDL decreases associated with irradiation. Similar investigations were carried out on mice subjected to a 24-hour fasting period. Whereas the LDL and plasma glycerides displayed significant reductions, the high-density lipoproteins (HDL) and phospholipids increased in plasma concentrations. In addition the fatty acid distributions of the LDL, HDL, and plasma glycerides of the fasted mouse showed some significant differences when compared with the controls. (auth)

21976 COMPARISON OF ELECTRORETINAL RESPONSE TO X-RAYS AND TO LIGHT. C. S. Bachofer (Univ. of Notre Dame, Ind.) and S. Esperance Wittry. Radiation Research, 17: 1-10(July 1962).

The ability of the grass frog, Rana pipiens, to elicit an electroretinogram in response to x rays and to light has been investigated. Typical electroretinograms in response to x rays and to light over a wide range of stimulus intensities and durations afford a comparison of the two responses. Quantitative measurements of amplitude, latent period, rate of rise, and duration, plotted as a function of intensity of stimulus and duration of stimulus, yield three-dimensional graphs which sharply contrast the properties of the response to light and to x-rays. Although a remarkable sensitivity of the frog retina to x rays was observed, the response, which, under certain conditions was indistinguishable from the response to light, proved to be a weaker response as judged by the various parameters measured. (auth)

21977 MODIFICATION OF INTESTINAL RADIATION DEATH BY SURGICAL MEANS. James W. Osborne (Univ. of Iowa, Iowa City). Radiation Research, 17: 22-23(July 1962).

A dose of x irradiation which was a LD_{100} in about 8 days was given to at least 50% of the exteriorized ileum and jejunum of young adult male Holtzman rats. In some, this was the only treatment; in others, the irradiated segment was made into a Thiry or Thiry-Vella fistula 2 days postirradiation. This procedure extended the survival time an average of 4 days beyond that of irradiated controls; some animals lived 14 days longer. Establishing a fistula with the irradiated segment did not modify histological damage but did apparently reduce the bloody diarrhea and water loss via rectum ordinarily seen in irradiated controls. The significance of these findings and their compatibility with current theories of causes of intestinal radiation death is discussed. Although the postirradiation resection or conversion into a fistula of the irradiated exteriorized intestine did prolong survival time when compared to irradiated controls with the gut left in place, resection was not of value when done prior to whole-body irradiation or after abdomen exposure, since survival times were as usual (about 3½ days). The results show that it is possible to produce 3- to 5-day death in rats with an exposure dose as low as 1500 r, even though the in-

fluence of the major portion of the small intestine is absent. This is in contrast to the response of the mouse where at least 50% of the jejunum and ileum must be irradiated to produce intestinal death. (auth)

21978 EFFECTS OF OXYGEN ON THE INACTIVATION OF ENZYMES BY IONIZING RADIATIONS. II. SOLID TRYPSIN AND DEOXYRIBONUCLEASE. J. A. V. Butler and A. B. Robins (Royal Cancer Hospital, London). Radiation Research, 17: 63-73(July 1962).

The inactivation of solid trypsin by ionizing radiation has been studied in the presence and in the absence of oxygen. With 15-Mev electrons applied in pulses (2.5×10^7 rads/sec in the pulse), no oxygen effect is observed, but oxygen increases the amount of inactivation at low dose rates. In the case of deoxyribonuclease an oxygen effect was observed even with the pulsed electrons. The lack of an oxygen effect with trypsin at high dose rates is attributed to the slowness of reactions involving oxygen. It is found, however, that when cysteine is present oxygen has a marked effect even at the high dose rates. The inactivation dose of the solid depends markedly on its method of preparation. In the most sensitive state at least four molecules of the enzyme are inactivated by one ionization. Some theoretical considerations are given, based on the concept that additives, such as cysteine, may facilitate the neutralization of the charged molecules formed by the initial ionizations. (auth)

21979 EFFECT OF GAMMA RAYS ON SOLUTIONS OF ADENOSINE TRIPHOSPHATE AND RIBOSE. E. B. Vaisey and F. S. Thatcher (Dept. of National Health and Welfare, Ottawa). Radiation Research, 17: 74-81(July 1962).

The irradiation of aqueous solutions of adenosine triphosphate (ATP) with 6×10^5 rads of Co^{60} γ-rays principally led to the release of free adenine and to the destruction of ribose. Adenine and the phosphate ester bonds were affected to a comparatively minor degree. It was deduced that the primary attack on ATP was at the 1'-carbon atom. When free D-ribose was irradiated, several acids with reducing groups were found to be the principal products. It was assumed that these acids could be derived by further oxidation of ribopenturonic acid. The G value was 2.30 for ribose destruction and 1.16 for formation of the carboxyl group. (auth)

21980 RELATIONSHIPS BETWEEN CELL DIVISION AND DEATH IN X-IRRADIATED CHLAMYDOMONAS CULTURES. Baruch S. Jacobson (Univ. of Texas, Austin). Radiation Research, 17: 82-91(July 1962).

The time of occurrence of postirradiation death has been studied in Chlamydomonas reinhardi. Death usually occurs at a time when 4 or 8 daughter cells have been produced. The daughters are uninucleate. In the normal division cycle, 4 or 8 nuclei are produced by successive mitoses, before cytoplasmic division begins, at which time a multinucleate cell is rapidly reduced to a colony containing a corresponding number of uninucleate cells. Prior irradiation does not interrupt this series of division events but prevents the uninucleate progeny from undergoing further mitosis. In some cases, death is not preceded by division. Dose fractionation reduces killing but does not preferentially affect predivisional or postdivisional death. The relative frequencies of early and late death depend on the effective dose. The number of daughter cells formed are equal to the number of nuclei formed. These observations suggest that an irreversible radiation-induced division block is the result of interference with some process occurring only in the uninucleate stage. (auth)

21981 MODIFICATION OF THE RADIATION EFFECT ON HAIR ROOTS OF THE MOUSE BY ACTINOMYCIN. Melvin L. Griem and Klaus Ranniger (Univ. of Chicago). Radiation Research, 17: 92-100(July 1962).

A technique is described for the microscopic examination of rodent hairs. Actinomycin D was shown to exert a synergistic effect on dysplastic changes of growing hairs induced by local x irradiation. (C.H.)

21982 STUDIES ON RADIATION-INDUCED MAMMARY GLAND NEOPLASIA IN THE RAT. VII. THE EFFECTS OF FRACTIONATION AND PROTRACTION OF SUBLETHAL TOTAL-BODY IRRADIATION. Claire J. Shellabarger, Victor P. Bond, and Eugene P. Cronkite (Brookhaven National Lab., Upton, N. Y.). Radiation Research, 17: 101-9(July 1962). (BNL-5815)

Female Sprague-Dawley rats were given a total-body exposure of 400 r of 250-kvp x rays either in a single dose, in five successive daily exposures, or in eighteen successive daily exposures, the mid-point of each exposure being the fortieth day of age. The cumulative incidence of mammary neoplasms 12 months later was: 24/31 = 77%; 19/31 = 61%; and 18/31 = 58%. These frequencies did not differ statistically from one to the other but were clearly greater than the 3/31 = 10% incidence in the controls. The incidence of nonmammary tissue neoplasia did not exceed 6% in any group, and no conclusions could be drawn about the effect of fractionation and protraction on this response. It was concluded that within the limits of the experiment the neoplastic response of rat mammary tissue was independent of fractionation and protraction and thus is not inconsistent with a nonthreshold direct mechanism for the primary event leading to neoplasia induction by sublethal to total-body irradiation. (auth)

21983 RADIATION-INDUCED CHROMOSOMAL ABERRATIONS AND LETHALS IN ASPERGILLUS NIDULANS. M. Anne Tector and Etta Kaefer (McGill Univ., Montreal). Science, 136: 1056-7(June 22, 1962).

The frequency of translocations induced in diploid conidia of Aspergillus nidulans by gamma rays was much higher than that of recessive mutants involving a single chromosome. More than half of the surviving nuclei contained viable translocations at radiation doses within the range normally employed for induction of mutants in microorganisms. (auth)

21984 EFFECTS OF X-IRRADIATION ON PHOSPHATASE ACTIVITY IN MTK III ASCITES SARCOMA OF RATS. K. Iwasa (Tokushima Univ. School of Medicine, Japan). Shikoku Igaku Zasshi, 16: No. 2, 649(1960).

Alkaline phosphatase activity in MTK III ascites sarcoma of rats was not influenced by x irradiation of 200 r to 1,000 r. Some increasing activity, however, was found after x irradiation of 5,000 r. Acid phosphatase activity also showed the same tendency. In vitro irradiation of 1,000 to 5,000 r caused the same changes in phosphatase activity as in vivo irradiation of 5,000 r. An increase of activity may be due to isolation of enzyme molecules due to cell destruction after irradiation. (auth)

21985 EXPERIMENTAL STUDIES ON THE INTRAPELVIC DOSE-DISTRIBUTION OF ^{137}Cs γ-RAY AND 290 kVp X-RAY. H. Tachiiri, Y. Shigematsu, T. Yamazaki, and K. Miyata (Osaka Univ.). Urol. Inter., 12: 111-21 (1961). (In English)

So far as the percentage depth dose is concerned, Cs^{137}-teletherapy falls between Co^{60} γ-ray and conventional 200 kvp x ray. The advantages and disadvantages of Cs^{137} are summarized. (auth)

21986 THE PRODUCTION OF SUBSTANCES OF VERY HIGH BIOLOGICAL EFFICIENCY BY IRRADIATION OF AGAR WITH HIGH DOSE OUTPUTS. K. Sommermeyer and H. Magnus (Universität, Freiburg i. Br. and Städt. Krankenanstalte, Karlsruhe, Ger.). Z. Naturforsch., 17b: 173-8 (Mar. 1962). (In German)

In an earlier work it was shown that in the preliminary irradiation of agar with x rays, α particles, and uv very effective inactivating substances (IS) arise, and that their formation took place in several stages (multi-hit IS). Only B. coli were used as test objects. Staph. aureus and B. subtilis were inactivated after preliminary irradiation of the agar with x rays, but not after irradiation with α particles or uv. It is probable or to be suspected that the IS arising in the preliminary radiation with α particles can and uv can penetrate the cell membrane of B. coli but not that of Staph. aureus and B. subtilis. If B. coli is irradiated directly on the agar with α particles so that the dose rate is varied, a dependence of the inactivation probability on dose rate is found. This is explained by diffusion of the multi-hit IS to the cells during irradiation. A comparative investigation of the inactivation of B. coli by direct irradiation on agar and on glass shows that in agar no one-hit IS occurs (that is, no IS was formed by a single hit or elementary act) or at least these do not penetrate through the cell membranes of B. coli. (tr-auth)

21987 EFFECT OF X RAYS ON THE TPN PHOTOREDUCTION IN ISOLATED CHLOROPLASTS. S. von Falck and G. Jacobi (Tierarztlichen Hochschule, Hanover). Z. Naturforsch., 17b: 207-9(Mar. 1962). (In German)

The present study is an extension of investigations of radiation effects on function systems of chloroplasts in dependence. Dividing chloroplasts (C_1) were suspended in 0.2% NaCl solution (C_{11}) and centrifuged. The precipitate was suspended and the chloroplast extract (CE) centrifuged a second time in order to remove the residual chlorophyll. Both fractions were irradiated separately and tested to determine the activity of the TPN photoreductase. The results show that both "particles" (C_{150}) and the chloroplasts extract suffer radiation damage. The variation in the height of the activity values and in the radiation resistance is explained by the age of the leaf material used. Chloroplasts from young leaves have a higher activity and higher radiation resistance. By combination of irradiated "particles" with non-irradiated CE or vice versa the inhibition of TPN reduction and enzyme activity was additive, and no limiting stage of one fraction was detected. It is therefore assumed that a factor that is affected by x radiation is present in both fractions. (J.S.R.)

21988 PROBLEMY RADIATSIONNOI GENETIKI. (Problems of Radiation Genetics). N. P. Dubinin. Moscow, State Publishing House of Literature on Nuclear Science and Technics, 1961. 468p.

A theoretical analysis is made of radiation processes and biological and genetic effects of radiation. The structural, physical, and chemical principles of genetics and the genetic effects of ionizing radiation and ultraviolet rays on animals, plants, microorganisms and viruses are discussed. Evaluations are made of the radiation hazard in human genetics and of protective measures against radiation damage. 886 references are included. (R.V.J.)

Radiation Sickness

21989 (JPRS-13821) THE EFFECT OF ADRENOCORTICOTROPIC HORMONE (ACTH) ON THE CLINICAL COURSE OF ACUTE RADIATION SICKNESS IN HYPOPHYSECTOMIZED RATS. A. A. Grafov. Translated from Problemy Endokrinol. i Gormonoterap., 8: No. 2, 57-64 (1962). 12p.

Surgical removal of the hypophysis reduced the general radioresistance of white rats, causing acute radiation sickness with a dose of 100 r. The mortality rate after irradiation of hypophysectomized rats ranged from 37 to 40%, and there was no mortality in non-operated irradiated animals during a 45 day observation period. The administration of ACTH to hypophysectomized rats contributed to the elimination of leukocytosis and delayed the development of erythropenia. ACTH injections in hypophysectomized rats after irradiation increased radiation leukopenia without exerting any effect on the erythropoietic function of the bone marrow. The maximum reduction in the total white blood count of irradiated hypophysectomized rats which received ACTH was 18% less than in the hypophysectomized irradiated animals which did not receive hormone therapy. Blood pressure, temperature, weight, and survival rate indexes in hypophysectomized irradiated animals with and without ACTH were approximately the same. (P.C.H.)

21990 INCREASED SURVIVAL FROM RADIATION BY MIXTURES OF RADIOPROTECTIVE COMPOUNDS. R. I. H. Wang and J. G. Kereiakes (Army Medical Research Lab., Fort Knox, Ky.). Acta Radiol., 58: 99-104(Apr. 1962). (In English)

Serotonin, MEA (β-mercaptoethylamine), and AET (S,β-aminoethylisothiuronium) are effective protectors against ionizing radiation; 10 μM serotonin, 20 μM AET, or 30 μM MEA, when given alone to mice prior to exposure of lethal dose of 800 r, offered 50 to 65 per cent protection. At 1,100 r, no protection by any of these agents was found. However, when mixtures of the above agents (5 μM serotonin plus 10 μM AET or 5 μM serotonin plus 30 μM MEA) were administered, 100 per cent and 70 to 80 per cent protection were obtained in mice exposed to 800 r and 1,100 r, respectively. (auth)

21991 THE EFFECT OF RADIOPROTECTIVE CHEMICALS ON PHOSPHORESCENT EMISSION OF RIBOFLAVINE IN OXYGENATED AND DEOXYGENATED SOLUTIONS. H. A. S. van den Brenk and Dana Jamieson (Cancer Institute Board, Melbourne). Experientia, 18: 231-3(1962). (In English)

Studies were made to determine the behavior of certain fluorescent dyes (riboflavine, acridine, and rhodamine) in frozen solution with regard to the stability of the triplet state in the presence of certain radioprotective compounds under aerobic and anaerobic conditions. It was found that the absence of oxygen had little influence on the responses of rhodamine and acridine to the various agents tested. For riboflavine, it was found that the quenching of phosphorescence caused by the exclusion of oxygen from the solution could be reversed by cysteamine, cystamine, cysteine, cystine, 2-aminoethyl isothiouronium bromide, aminoethyl thiosulfuric acid, 2-methyl allyl isothiouronium chloride, and glutathione. With the exception of cystine, all of the active compounds are radioprotective agents in vivo. (M.C.G.)

21992 ACUTE RADIATION INJURY: PATHOPHYSIOLOGICAL ASPECTS OF THE MASSIVE LEAKAGE OF ALBUMIN INTO THE GASTROINTESTINAL TRACT. G. Birke, S. O. Liljedahl, L. O. Plantin, and J. Wetterfors (King Gustaf Vth Research Inst. and Radiumhemmet Karolinska Sjukhuset, Stockholm). Nature, 194: 1243-5 (June 30, 1962).

Rabbits were irradiated with 250 to 1600 r Co^{60} γ rays, and the degradation and distribution of albumin in the ani-

mals were investigated by means of I^{131}-labeled albumin injected intravenously after irradiation. The half life of the labeled albumin was found to be inversely proportional to the radiation dose, indicating an increased albumin catabolism and leakage through the gastrointestinal wall. The excessive excretion of radioactivity in the rabbit irradiated with 1200 r indicates partial restitution of the re-absorption capacity of the intestine. It is concluded that the epithelium and capillaries of the gastrointestinal tract constitute the most sensitive system in acute radiation injury. (D.L.C.)

21993 HEMATOLOGICHESKIE SDVIGI PRI OSTROI LUCHEVOI BOLEZNI VYZVANNOI NA BETATRONE 25 Mev. (Hematological Changes in Acute Radiation Sickness Induced by Radiation from a 25 Mev Betatron). E. D. Gol'dberg. Tomsk, USSR, Publishing House of Tomsk University, 1960. 48p.

Biological effects of various radiation doses are discussed, and lethal doses for humans and various animals are tabulated. Hematological changes induced by betatron rays and data on changes in blood picture and marrow in guinea pigs during acute radiation sickness are discussed. The changes in Kurlov's bodies, ergthrocytes, nucleic acid in blood cells, and the potential in marrow reticular cells during acute sickness in animals are also discussed. An appendix of microphotographs of blood and marrow taken during acute stages is included. (R.V.J.)

CHEMISTRY

General and Miscellaneous

21994 (ORNL-TM-150) CHEMICAL TECHNOLOGY DIVISION, UNIT OPERATIONS SECTION MONTHLY PROGRESS REPORT, JANUARY 1962. M. E. Whatley, P. A. Haas, R. W. Horton, A. D. Ryon, J. C. Suddath, and C. D. Watson (Oak Ridge National Lab., Tenn.). June 6, 1962. Contract [W-7405-Eng-26]. 42p.

The experimental investigation of the reaction of H_2, CO, and CH_4 with CuO was extended to the range of concentration of 100 ppm or less of the contaminant in helium. The 250 ton prototype shear was dismantled for replacement of the stainless steel connecting rod with a chromium plated one equipped with a metal wiper. Inspection of the various shear components indicated negligible wear after ~1000 cuts on porcelain filled ORNL Mark I prototype fuel assemblies. The slip angle of sheared pieces in the leacher appears to be dependent on batch size and not on material type. HETS values for extraction and stripping using uranium as a stand-in for plutonium were determined as part of the amine extraction final cycle plutonium flowsheet studies. Installation of the 14-in.-ID rotary denitrator was completed and nine runs were made without mechanical difficulty but a creamy fraction and poor sol characteristics were observed. Installation of a weir in the aqueous leg of the Belgian mixer-settler between the mixer and settler resulted in better control of the aqueous-organic interface and organic backmixing. (auth)

21995 THE PREPARATION OF ION-EXCHANGE RESIN MEMBRANES FROM POLYETHYLENE-STYRENE GRAFT COPOLYMERS DERIVED UNDER γ-IRRADIATION. Tetsuya Uchino and Hiroshi Hani. Asahi Garasu Kenkyû Hôkoku, 10: 17-28 (June 1960).

A γ-irradiated styrene-polyethylene graft-copolymer film is suitable for sulfonation and gives a strong acid-type cation-exchange resin membrane having good electrochemical and mechanical properties. The grafting of styrene increased with increasing dosage, film thickness, polyethylene crystallization, and decreasing temperature. The degree of crystallization of polyethylene plays an important role in the grafting process. Using the copolymer film, the cation exchange membranes were prepared by sulfonation with chloro-sulfonic acid and anion-exchange membranes by chloro-methylation and amination. The specific resistance of the membranes was 200Ω-cm in 0.5 N NaCl solution. The transport numbers of Na and Cl ions within the cation and anion-exchange membranes were 0.93 and 0.97, respectively, for the NaCl solutions ranging from 0.5 to 1 N. (OID)

21996 FLUORIDES. OTS Selective Bibliography. (Office of Technical Services, Washington, D. C.). Feb. 1962. 17p. $0.10(OTS) (SB-492)

References (182) are given to reports, patents, and translations published from 1946 to February 1962. A separate list of 3 bibliographies is given in which abstracts of patents on fluorides appear. (P.C.H.)

21997 FLUORINE AND FLUORINE COMPOUNDS. OTS Selective Bibliography. (Office of Technical Services, Washington, D. C.). Feb. 1962. 16p. $0.10(OTS) (SB-491)

References (254) are given to reports and translations published from 1946 to February 1962. Three references are given to bibliographies in which abstracts of patents on fluorine and fluorine compounds appear. (P.C.H.)

21998 FLUOROCARBONS. OTS Selective Bibliography. (Office of Technical Services, Washington, D. C.). Feb. 1962. 8p. $0.10(OTS) (SB-493)

Seventy-nine references are given to reports and translations published from 1946 to February 1962. Two references are given to bibliographies in which abstracts of patents on fluorocarbons appear. (P.C.H.)

21999 KINETICS OF FAST INTERFACIAL REACTIONS WITH PARTICULAR REFERENCE TO METAL DISSOLUTION. H. E. Hoelscher and Chatten Cowherd, Jr. (Johns Hopkins Univ., Baltimore). IAEA Preprint CN-13/26. 34p. (In English)

To be published in the Proceedings of the IAEA Conference of the Corrosion of Reactor Materials in Salzburg, 4-9 June 1962.

In spite of the vast amount of attention to the field of liquid/solid interfacial chemical reactions (including corrosion, metal dissociation and catalytic reactions) there has been little unequivocal data on the chemical kinetics of such reactions. This is primarily because of the extraordinary experimental difficulties encountered in measuring the kinetics of such fast reactions. Normally one finds that the experimental data show marked contributions from the effects of flow past the surface under study and that, hence, one is observing diffusional rates and not chemical reaction rates. An analytical technique is proposed by which suitable experimental data may be used to compute the actual surface kinetic (rate) constant free from a contribution from the fluid phase diffusional steps. This technique, both experimental and analytical, was studied and proved to be successful. It was applied to one very fast interfacial chemical reaction (the iodine dissolution in potassium iodide) and will now be applied to corrosion reactions to obtain what is possibly the first systematic analysis of the rate constant for such reactions. (auth)

Analytical Procedures

Refer also to abstract 21907.

22000 (AERE-M-1004) A NEW METHOD FOR THE DETERMINATION OF IODINE-131 IN HERBAGE INCLUDING MEASUREMENTS MADE IN AUTUMN 1961. A. Morgan and G. R. Mitchell (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Apr. 1962. 11p.

A radiochemical method for the determination of iodine-131 in samples of herbage was developed to supercede the distillation method employed in the past. The modified method enables a larger sample to be analyzed, thus reducing the sampling error and increasing the sensitivity. Results obtained by the modified chemical method on herbage samples collected during the Russian series of nuclear weapons tests in late 1961 are compared with results obtained on the same sample using the distillation method, and results obtained by gamma spectrometric analysis of a number of samples. Levels of iodine-131 in herbage and milk samples collected at this time are compared. (auth)

22001 (HW-71517) SPECTROCHEMICAL DETERMINATION OF RARE EARTH ELEMENTS AT HANFORD. R. Ko (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 17, 1962. Contract AT(45-1)-1350. 8p.

Two general spectrochemical methods used at Hanford for the determination of rare earth elements in non-rare earth matrices are described. Two other specific applications of rare earth analysis are also presented. One is the determination of neodymium in praseodymium and of praseodymium in neodymium using d-c arc excitation good to ±10%. The other is the determination of cerium and neodymium using copper spark excitation good to ±7%. (auth)

22002 (JEN-100-DQ/I-31) DETERMINACION ESPECTROFOTOMETRICA DE MICROCANTIDADES DE URANIO PREVIA EXTRACCION CON METILISOBUTILCENTONA-FOSFATO DE TRIBUTILO. (Spectrophotometric Determination of Microamounts of Uranium Previous Extraction with TBP-MIC). J. Vera Palomino, F. Palomares Delgado, J. Petrement, and R. Fernandez Cellini (Spain. Junta de Energia Nuclear, Madrid). 1962. 41p.

Selective extraction of uranium in nitric acid medium with a mixture of TBP-MIC (1 : 10) was achieved. Aluminum nitrate was used as salting agent. Complexing agents were added to avoid extraction of impurities. Extraction conditions were studied so that extraction is almost practically complete in a single run. Uranium was determined by colorimetry by the method of Joe Will and coworkers based on the yellow color developed by the complex of uranium with dibenzoylmethane. The method was modified to be applicable in alcoholic medium extraction. The optical density is measured with a spectrophotometer at 410 mμ. Statistical treatment of the results was compared with the $NaOH-H_2O_2$ method, in which uranium is first separated by ion-exchange and the confidence bands for the calibration curves were determined. (auth)

22003 (NP-11548) DETERMINATION OF BERYLLIUM BY GAMMA-RAY ACTIVATION. Mines Branch Technical Bulletin TB-33. Hugh P. Dibbs (Canada. Dept. of Mines and Technical Surveys. Mines Branch). Mar. 1962. 17p.

Available from Can. Dept. Mines and Tech. Surveys, Mines Branch. ($0.25).

An apparatus is described for the quantitative analysis of the beryllium content of powdered samples down to approximately 50 ppm of beryllium. The analytical technique is based upon the photoneutron reaction $Be^9(\gamma,n)Be^8$ and employs antimony-124 as the gamma source. A description is given also of a second apparatus for the qualitative screening of rock samples for beryllium content. (auth)

22004 (PG-Report-317) ANALYTICAL METHOD FOR THE ABSORPTIOMETRIC DETERMINATION OF BORON IN AMMONIA SOLUTION. (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). 1962. 5p.

A weighed sample is evaporated to dryness with caustic soda solution on a water bath. The residue is dissolved by adding a solution of curcumin in acetic acid. After adding a mixture of H_2SO_4 and acetic acid, the solution is allowed to stand at room temperature for 15 minutes. The solution is then diluted to 100 ml with ethanol, and a portion is filtered and measured absorptiometrically on the residue as the curcumin complex. (P.C.H.)

22005 (PG-Report-325) ANALYTICAL METHOD FOR THE RAPID DETERMINATION OF NICKEL IN URANIUM METAL AND URANIC COMPOUNDS. (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). 1962. 5p.

Supersedes SCS-M-52A.

The sample is dissolved in nitric acid or a nitric/hydrochloric acid mixture and the excess acid is removed by evaporation to dryness. The residue is dissolved in water, ammonium citrate is added to complex uranium, followed by bromine water to oxidize the nickel. The solution is then made alkaline with ammonia, dimethylglyoxime solution is added, and the nickel concentration determined by measuring the absorbancy of the complex formed. (P.C.H.)

22006 (PG-Report-334) ANALYTICAL METHOD FOR THE DETERMINATION OF IODINE-131 IN REACTOR FUEL PROCESSING AND EFFLUENT TREATMENT PLANT SOLUTIONS. (United Kingdom Atomic Energy Authority. Production Group, Windscale, Sellafield, England). 1962. 7p.

Interchange between radioactive iodine and added carrier is obtained by an oxidation reduction cycle and the iodine is then extracted as the element into carbon tetrachloride. The iodine is extracted into dilute sodium bisulphite solution and precipitated as silver iodide. The β-activity of the precipitate is measured with a Geiger-Mueller counter. The method is applicable to samples (3×10^4 to 6×10^5 dpm) from the Windscale primary separation plant, uranium purification plant, and effluent treatment plant. (auth)

22007 (PG-Report-336) ANALYTICAL METHOD FOR THE DETERMINATION OF HYDRAZINE IN FEED AND BOILER WATERS. (United Kingdom Atomic Energy Authority. Production Group, Windscale, Sellafield, England). 1962. 3p.

A sample of the cooled water is mixed with para-dimethylaminobenzaldehyde dissolved in acidified alcohol. The intensity of the yellow color produced is measured with an absorptiometer. The method is suitable for the direct determination of hydrazine (0 to 0.3 ppm) in the feed and boiler waters at Calder Works. It is not suitable for colored waters or those containing suspended matter. (auth)

22008 (TIM-576) A FLUORESCENT X-RAY SPECTROGRAPHIC METHOD OF ANALYZING TITANIUM–COLUMBIUM ALLOYS. D. E. Fornwalt and J. Komisarek (Pratt and Whitney Aircraft Div., United Aircraft Corp., Middletown, Conn.). Oct. 7, 1958. Contract [AT(11-1)-229]. 7p.

The fluorescent x-ray method allowed the analysis of Ti–Nb alloys over a wide range of compositions. No primary standards are required since synthetic standards may readily be prepared. It is believed that the technique may be used to analyze any materials which can be converted to the oxide either by direct ignition or by chemical conversion to a suitable form which may then be transformed to an oxide, fusible in borax. (P.C.H.)

22009 (CEA-tr-R-1477) LE RADIOCHROMATOGRAPHE. (Radiochromatography). M. I. Yanovskii (Ianovskii), G. A. Gaziev, V. P. Nikiforov, M. G. Batrukova, Yu. (Iu.) A. Golant, and [V. S.] Kornyakov (Korniakov). Translated into French from U.S.S.R. Patent No. 133,269. Byull. Izobret., No. 7, (1961). 5p.

The radiochromatograph for gas-vapor mixtures contains a chromatographic column, an apparatus for the regulation of the gas inlet current, an automatic sampling device, a column thermostat, a thermostat for the detectors, and a programming device for the sampling of fractions for the purpose of accelerating the analysis, determining the specific radioactivity of different components of the gas

and vapor, and obtaining and separating radiochemically the fractions. The detector for measuring concentration is directly connected with the radioactivity detector, in the form of a proportional counter. The automatic sampling equipment, working on the principle of refrigeration, is directly connected after the detectors. (J.S.R.)

22010 (TT-1022) DETERMINATION OF OXYGEN IN TITANIUM BY ISOTOPE DILUTION. R. Sh. Khalitov. Translated by V. N. Pavloff (National Research Council of Canada, Ottawa) from Trudy Komissii Anal. Khim., Akad. Nauk S.S.S.R., Inst. Geokhim. i Anal. Khim., 10: 129-36(1960). 10p.

The isotope dilution method was used for the determination of the oxygen content in titanium and TiO_2. The specimens were also analyzed by the method of vacuum fusion with the application of a coarse graphite powder. Comparison of the analytical results for the specimens analyzed by the two methods shows that the method of vacuum fusion lowers the results by approximately 20%. (auth)

22011 THE CONSTRUCTION OF A FABRY-PEROT SPECTROMETER FOR ISOTOPIC ANALYSIS. E. Weissman, M. Pascalău, H. Tintea, C. Ungureanu, and T. Fodor (Institutul de fizică atomică and Universitatea Babes-Bolyai, Cluj). Acad. rep. populare Romîne, Inst. fiz. atomică si Inst. fiz., Studii cercetări fiz., 12: 871-8(1961). (In Rumanian)

An apparatus for the utilization of interference fringes, based on a mechanical variation of the distance between Fabry-Perot calibration plates, is described. The results are recorded photoelectrically. The apparatus will be used to study fine and hyperfine structures and for isotopic analysis. (tr-auth)

22012 CONGRESS OF ANALYTICAL CHEMISTRY, BUDAPEST, 24-29 APRIL 1961. Acta Chim. Acad. Sci. Hung., 26: No. 1-4, 179-278(1961).

Thirteen papers are included which treat various topics relating to the use of radioisotopes and radiations in analysis and chemical reaction studies. Separate abstracts were prepared for all 13 papers. (D.L.C.)

22013 AUTOMATIC RADIOMETRIC TITRATION. J. Toelgyessy and V. Šajter. Acta Chem. Acad. Sci. Hung., 26: No. 1-4, 179-86(1961).

A simple apparatus constructed for automatic radiometric titration is described. The measuring solution is added continuously in equal quantities. The dependence of the activity in the solution above the precipitate is determined as a function of time; this dependence is registered automatically. A definite amount of test solution corresponds to a definite time interval. During the titration, the measured solution circulates through the titration flask, through the G-M counters and back into the flask. The circulation is kept up by a micro-pump. The automatic apparatus excludes subjective errors, increases the precision, and decreases the titration time. One determination takes about 5-8 min. The titration of Cl ions with Ag^{110} ions is used as an example. (auth)

22014 CONTRIBUTIONS TO THE EFFECT OF SOLVENT AND MIXTURES OF SOLVENTS IN THE ISOTOPIC EXCHANGE REACTION. DETERMINATION OF CONCENTRATIONS VIA THE RATE OF ISOTOPIC EXCHANGE. E. Koeroes. Acta Chem. Acad. Sci. Hung., 26: No. 1-4, 187-93(1961).

The isotopic exchange reaction of iodine atoms between I^{131}-labeled 4-iodo-antipyrene (1-phenyl-2,3-dimethyl-4-iodo-pyrazolone) and elementary I was studied in different solvents, and the half time of the exchange ($t_{\frac{1}{2}}$) was measured. The unequivocal effect of the dielectric constant was demonstrated. The water content of the solvent greatly affected $t_{\frac{1}{2}}$. The important role of I^+ ions in the exchange reaction was noted. (auth)

22015 THE ANALYTICAL CHEMISTRY OF RADIOISOTOPE PREPARATIONS. A. Almásy. Acta Chem. Acad. Sci. Hung., 26: No. 1-4, 195-202(1961).

The methods for controlling the purity of radioisotopic samples are discussed. Data on contamination in singular cases can be obtained by physical methods, γ- or β-ray spectroscopy, and decay curves. Classical analytical methods often fail. The methods of paper chromatography, ion-exchange chromatography, paper electrophoresis and polarography are discussed. The application of ion-exchange chromatography is shown in the analysis of rare earth samples. (auth)

22016 THE DETERMINATION OF THE CHLORINE CONTENT OF CHLORINATED HYDROCARBONS BY THE ABSORPTION OF RADIOACTIVE RADIATION. T. Bálint. Acta Chem. Acad. Sci. Hung., 26: No. 1-4, 203-9(1961).

A method, based on the principle of x-ray absorption, was developed for the determination of the Cl content in chlorinated hydrocarbons. A 5-mc Fe^{55} sample was used as the radiation source. The standard deviation of the results was ±0.022% Cl, which corresponded to the error in the S determination. The method can also be used for determining the content of other hetero atoms in hydrocarbons and can even be used in cases where the mixture examined contains several types of atoms of high absorptivity as long as the components have fixed proportions. (auth)

22017 RADIOCHEMICAL INVESTIGATION OF PRECIPITATION EXCHANGE REACTIONS. I. CHLORIDE EXCHANGE WITH SILVER IODATE. L. Érdey, E. Bányai, and F. Szabádvary. Acta Chem. Acad. Sci. Hung., 26: No. 1-4, 211-18(1961).

Precipitation exchange reactions using radioisotopes allow a more detailed investigation of the course of reactions than ordinary titrations. The chloride exchange with silver iodate was investigated by means of Cl^{36}-labeled chloride and Ag^{110}-labeled silver iodate solutions. The results are tabulated. (auth)

22018 RADIOCHEMICAL INVESTIGATION OF PRECIPITATION EXCHANGE REACTIONS. II. CHLORIDE EXCHANGE WITH SILVER CHROMATE. L. Érdey, I. Porubszky, and D. Hegedues. Acta Chem. Acad. Sci. Hung., 26: No. 1-4, 219-27(1961).

The equilibrium ion concentrations established during the course of reactions can be determined experimentally through radiochemical investigations of precipitation exchange reactions. Furthermore, the total titration error can be resolved into positive and negative factors which result from the physical solubility of the exchanger and the solubility equilibrium existing between the 2 precipitates. In the example described, the chloride exchange with silver chromate by means of Cl^{36}-labeled chloride and Ag^{110}-labeled silver chromate solutions was investigated. It was found that theoretical and experimental values were in good agreement. (auth)

22019 POLAROGRAPHY IN ACTIVATION ANALYSIS. Z. Ferenczy. Acta Chem. Acad. Sci. Hung., 26: No. 1-4, 229-34(1961).

The use of polarography after the activation of elements for determining impurities of minute components in metallic compounds and alloys is discussed. Various examples are cited. (auth)

22020 ACTIVATION ANALYSIS PURITY TESTS OF TARGETS FOR ISOTOPE PRODUCTION. H. Niese. Acta. Chem. Acad. Sci. Hung., 26: No. 1-4, 235-41(1961).

Many radioisotopes are produced by irradiation of the purest chemicals obtainable in a reactor. Impurities in the targets can lead to undesirable side activities. The method of activation analytical purity-testing was applied to several target materials. The determination of silver and iridium in gold samples is described in detail. (auth)

22021 THE DETERMINATION OF THE SELENIUM CONTENT OF NICOTINIC ACID BY NEUTRON ACTIVATION ANALYSIS. V. Otvinovskii and Yu. V. Yakovlev. Acta Chem. Acad. Sci. Hung., 26: No. 1-4, 243-51(1961).

The method developed is based on the measurement of Se^{75}. This method can be used for γ-spectrometry as well as for radiometry. (auth)

22022 SOME DATA ON THE ACTIVATION ANALYSIS OF HIGH PURITY SILICON. M. Oerdoegh and V. Upor-Juvancz. Acta Chem. Acad. Sci. Hung., 26: No. 1-4, 253-8 (1961).

Polycrystalline silicon samples contaminated by Ta, Au, Cu, Ni, and Co were irradiated in a reactor at a neutron flux of 10^{13} n/cm²/sec with an exposure time chosen so that measurable quantities of most impurities assumed to be present could be obtained. The method, which can be used for the determination of most impurities in silicon, is very rapid, accurate, highly sensitive, and specific. It can be used very well to determine impurities in semiconductors. (auth)

22023 THE USE OF BACKSCATTERING OF β-RADIATION IN PHARMACEUTICAL ANALYSIS. P. Schiller and J. Majer. Acta Chem. Acad. Sci. Hung., 26: No. 1-4, 259-65(1961).

A method, based on the use of backscattering of β-radiation, for determining elements with higher atomic numbers in pharmaceutical preparations is discussed. The apparatus and a control apparatus, which regulates automatically the quantities of the raw materials used, are described. The applicability of the method is shown in several samples containing iodine and mercury, in which the concentrations are a linear function of the backscattered β-radiation. (auth)

22024 RADIOMETRIC TITRATIONS WITH Ag^{110} AS AN INDICATOR. Gy. Straub and Z. Csapó. Acta Chem. Acad. Sci. Hung., 26: No. 1-4, 267-72(1961).

The use of radioisotopes as indicators shows 3 advantages: (1) the chemical properties are identical with those of the inactive element, (2) the determination of the quantity and location of a substance is possible, and (3) ultramicroquantities can be identified. The apparatus constructed for radiometric titrations is described, and the process is illustrated by the titration of oxalate ions, and vanadium- and cyanamide ions with Ag^{110}-labeled $AgNO_3$. The process is very exact for oxalate and cyanamide, but not applicable for vanadium because of the solubility and heterogeneous composition of the precipitate. (auth)

22025 EVALUATION OF PAPERCHROMATOGRAMS WITH β-BACKSCATTERING. J. Toelgyessy and V. Kriváň. Acta Chem. Acad. Sci. Hung., 26: No. 1-4, 273-8(1961).

The possibility of qualitative and quantitative evaluation of chromatograms by means of β-backscattering is discussed. The method requires the presence of elements with higher atomic number in the spots. An instrument and a practical example of the separation using Tl^{204} as the radiation source are described. (auth)

22026 FLUOROMETRIC DETERMINATION OF SUB-MICROGRAM QUANTITIES OF THORIUM. Claude W. Sill and Conrad P. Willis (Health and Safety Div., AEC, Idaho Falls, Idaho). Anal. Chem., 34: 954-64(July 1962).

A fluorometric method using morin in an alkaline solution of diethylenetriaminepentaacetic acid was developed that has a detection limit of 0.01 μg of thorium and a precision to about 0.5% on 5 μg, both at the 95% confidence level. Reliability and precision are achieved through use of a buffer system, an internal acid-base indicator, a permanent glass standard of fluorescence, and high concentrations of several different complexing agents. The fluorescent species contains thorium and morin in a mole ratio of 1 to 1. Because of its high sensitivity and tolerance to most of the common elements, the procedure is particularly applicable to the determination of thorium in air and water at concentrations well below the maximum permissible levels and in thorium ores and rare earths without separations of any kind. Even with siliceous materials, a determination can be completed in less than 1 hour. (auth)

22027 THE DETERMINATION OF SILVER BY ACTIVATION WITH BREMSSTRAHLUNG. L. I. Bilefield (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Analyst, 87: 504-8(June 1962).

A method was developed for determining silver in solid samples by bremsstrahlung activation to produce Ag^{107m} and Ag^{109m}. The gamma threshold for this excitation is less than 0.8 Mev, and the (γ,n) reaction does not occur at less than 9 Mev. For all samples tested, the activation results were lower than the volumetric, probably owing to the fact that the correction for self-absorption was calculated for samples containing silver only. The only elements that appear likely to interfere in the determination of silver are selenium and hafnium. With a counter of low background, it should be possible to determine silver at the 0.1% level. (M.C.G.)

22028 FLAME PHOTOMETRIC STUDIES. PART A: STUDIES OF THE EXTRACTION AND FLAME EMISSION OF YTTRIUM. PART B: DROPLET SIZE OF AEROSOLS IN FLAME PHOTOMETRY. PART C: STUDIES OF THE REACTION ZONE OF AN OXYGEN-ACETYLENE FLAME. William Joseph Carnes (Univ. of Tennessee, Knoxville). Dissertation Abstr., 22: 3834-5(May 1962).

The Beckman DU flame spectrophotometer was employed in a study of the emission characteristics in an oxygen-acetylene flame of the yttrium oxide bands which crest at 597 and 613 mμ. A 400-fold enhancement in the emission sensitivity of yttrium was obtained when a 4-methyl pentan-2-one solution of yttrium as the 2-thenoyltrifluoroacetone chelate was aspirated in place of an aqueous solution. The emission sensitivities of the two band heads were 0.25 μg of yttrium per ml. per 0.1 mv. at 597 mμ and 0.55 μg per ml. per 0.1 mv. at 613 mμ. The optimum ratio of oxygen to acetylene flows range between 3.0 and 3.8 for maximum emission intensity and a favorable flame and background stability. The effect of 19 cationic and 9 anionic species commonly encountered with yttrium was determined. Several applications of a flame-photometric method of analysis for yttrium in the 2- to 10-parts-per-million range are suggested. Droplet-size distributions in aerosols of water, 4-methyl pentan-2-one, and chloroform from the Beckman Model 4030 integral aspirator-burner were determined. Impaction upon a microscope slide, which was coated with a uniform layer of magnesium oxide, was employed. The droplet sizes were tabulated in size groups about a nominal size (±5 microns) in intervals of 10 microns over the range from 0 to 70 microns. The special upper-limit function of the log-normal distribution function was chosen to represent the droplet size distribution in each aerosol and the parameters associated with the upper-limit function were evaluated for the three aerosols. The geometric and Sauter mean diameter placed the aerosols in

the order of decreasing diameter: water > 4-methyl pentan-2-one > chloroform. A light-pipe was developed which permitted the various regions of an oxygen-acetylene flame to be viewed selectively apart from the remainder of the flame. The reflections from the walls of the light-pipe also provided an enhancement of the signal. The signal-to-background ratio was also greatly improved by the use of the light-pipe. In particular, the emission spectra of several elements from the reaction zone of an oxygen-acetylene flame were explored. The emission sensitivities of the elements arsenic, antimony, bismuth, cadmium, mercury, platinum, and zinc in an oxygen-acetylene flame were found to surpass the values that have been reported for these elements in an oxygen–cyanogen flame. A flame-spectrophotometric method would appear to be feasible for arsenic, antimony, and bismuth.

22029 CONTRIBUTIONS TO ISOTOPE GEOLOGY OF THE ELEMENTS HYDROGEN, CARBON, AND OXYGEN. I. Maass (Institut für Physikalische Stofftrennung, Leipzig). Isotopentechnik, 2: 111-16(Apr. 1962). (In German)

The isotopic composition of hydrogen and carbon in the water of crystallization of carnallites was determined. In the potassium salt occluded CO_2, the isotopic composition of the carbon was investigated. Further isotopic analysis were made on the carbon from natural gases and oils of varying structures. (tr-auth)

22030 EFFECT OF LOW HYDROGEN CONCENTRATIONS ON HALL EFFECT IN ZIRCALOY-2. W. G. Magnuson, Jr. (General Electric Co., Richland, Wash.). J. Appl. Phys., 33: 1904(May 1962). (HW-SA-2241)

The Hall effect is used to determine H_2 in Zircaloy-2 at 0 to 1.5% concentrations. A magnetic field of 1750 gauss is used, and the Hall current is found to vary linearly with H_2 content above 0.5%. The Hall coefficient of Zircaloy-2 is found to be -3.84×10^{-13} v · cm/amp · gauss. Further, the Hall voltage is found to be linear with magnetic field up to 4750 gauss. (T.F.H.)

22031 THE DETECTION OF LOW ACTIVITY IN AQUEOUS SOLUTION USING CERENKOV RADIATION. Shuji Yamada (Hitachi Central Research Lab., Tokyo). J. Phys. Soc. Japan, 17: 865-9(May 1962). (In English)

A method by which Sr^{90} activity in water can be detected at a concentration of about 10^{-7} $\mu C/cm^3$ is obtained, by using Cherenkov radiation from the water itself. For detecting such a low activity, a large detecting volume is required. Cherenkov radiation is very effective for the purpose, because the path length of Cherenkov radiation induced by the beta radiation is extremely large (about 15 cm for P^{32} beta particles) as compared with that of the beta ray in water. In an experimental apparatus having a 8-liter detecting volume, the background is found to be 420 cpm with a normal statistical fluctuation. The minimum activity level that can be detected reliably in the presence of the background is 8×10^{-8} $\mu C/cm^3$ for Sr^{90}. (auth)

22032 THE SENSITIVITY OF OXYGEN DETERMINATION BY ACTIVATION ANALYSIS IN REACTORS. W. Leonhardt (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Kernenergie, 5: 166-70(Mar. 1962). (In German)

If a sample is irradiated in a reactor together with a Li component, the oxygen concentration can be determined by the reaction sequence $Li^6(n,\alpha)t$, $O^{16}(t,n)F^{18}$. The sensitivity of the method depends on the total cross section σ_+ of the Li–O system. This was calculated for LiOH, Li_2CO_3, and $LiNO_3$ by an approximation method and was compared with experimental values. For the determination of oxygen in and on nickel foils, the foils were covered with foils of LiF and polystyrole. The σ_+ value of this combination was also calculated and experimentally determined. The oxygen determination yielded 2.6 μg O/cm^2 Ni foil. (tr-auth)

22033 GAS CHROMATOGRAPHY AS APPLIED TO NUCLEAR TECHNOLOGY. [PART] I. A. D. Horton (Oak Ridge National Lab., Tenn.). Nuclear Sci. and Eng., 13: 103-9(June 1962).

Gas chromatography was used to identify and to determine volatile products from the Homogeneous Reactor Test and from the processing of nuclear fuels and wastes. A gas chromatograph was constructed and used for part of the separations. It differed from conventional chromatographs in having an all-Pyrex gas-sampling system and all-Pyrex columns for use in the analysis of corrosive gases, that is, the oxides and chlorides of nitrogen. Temperature programming of the molecular-sieves column was used to advantage in the determination of the oxides of nitrogen and of carbon. The effect of the adsorption characteristics of type 5-A molecular sieves with respect to the adsorption–desorption of water and of nitric oxide was determined; both effects were significant in the analysis of mixtures of the oxides of nitrogen. The versatility of molecular sieves as an adsorbent in gas–solid chromatography was exploited. (auth)

22034 DETERMINATION OF CERIUM(IV) AND ITS SEPARATION FROM RARE-EARTHS WITH 1-HYDROXY-3-METHOXY XANTHONE. Brahm Dev and B. D. Jain (Univ. of Delhi). Proc. Indian Acad. Sci., Sec. A, 55: 213-15(Apr. 1962). (In English)

The use of 1-hydroxy-3-methoxy xanthone, in alcoholic solution, for determination of cerium was studied. The 1-hydroxy-3-methoxy xanthone forms a yellowish-brown complex with ceric salts which separates it from other rare earths. The reaction is quantitative between pH 2.0 and 8.5. (M.C.G.)

22035 INDIRECT DERIVATOGRAPHIC DETERMINATION OF CALCIUM, STRONTIUM AND BARIUM IONS IN THE PRESENCE OF ONE ANOTHER. L. Erdey, G. Liptay, G. Svehla, and F. Paulik (Technical Univ., Budapest). Talanta, 9: 489-93(June 1962). (In English)

For the determination of calcium, strontium, and barium in one sample, they are precipitated together in the form of the mixed oxalate hydrates. An aliquot of the precipitate is treated in a derivatograph fitted with a furnace that can be heated to 1150°. From the curves which result, the following values are obtained: precipitate weight, weight of carbon dioxide formed in the decomposition of calcium carbonate, and weight of carbon dioxide formed in the decomposition of strontium carbonate. From these three values, the amounts of calcium, strontium, and barium in the sample can be calculated. The values used for the calculations were chosen from five values after an evaluation of the possible errors. (auth)

22036 CONTINUOUS DETERMINATION OF URANIUM IN IMPURE SOLUTIONS BY GAMMA SPECTROMETRY. M. R. Hayes and A. P. Seyfang (United Kingdom Atomic Energy Authority, Preston, Eng.). Talanta, 9: 517-28(June 1962). (In English)

The non-destructive determination of uranium, by measurement of the 184-kev gamma activity arising from the decay of U^{235} was extended to the continuous monitoring of impure plant solutions. Interference in the gamma spectrometric measurement at 184 kev by the radioactive decay products of uranium was eliminated by means of an error signal. Measurement of the decay product gamma activity at higher energies was used to produce a signal which is injected, suitably proportioned and phased, into

the measurement channel. An instrument is described which is suitable for the monitoring of uranium streams containing 5 to 30% wt/v of natural uranium. Gross changes in the acidity and in the impurity content of the uranium stream had no appreciable effect on the indicated uranium concentration. (auth)

22037 SPECTRAL ANALYSIS OF MAGNESIUM–BERYLLIUM ALLOYS. V. F. Ercko, E. V. Lifshitz, V. G. Konovalov, I. G. Dubinsky, and N. I. Bugayeva (Inst. of Physics and Technology, Academy of Sciences, Ukr. S.S.R., Kharkov). Ukrain. Fiz. Zhur., 6: 837–42(1961). (In Russian)

The methods of spectral analysis of magnesium-beryllium alloys are considered. Beryllium (basic addition), aluminium, zirconium, and calcium were alloying additions. Copper, iron, and nickel were determined as noxious impurities. The determination of the impurities was carried out both by method of solution of a sample and by direct analysis of metal specimens. The determined concentration range was for beryllium 0.003 to 10%; for the other impurities 0.02–0.5%. A spectrophotometric method is proposed for determining beryllium in magnesium alloys. Sulfosalicylic acid was used as a complex former. The influence of magnesium was excluded by the addition of trilon B. The optical density was measured at $\lambda = 317$ mμ. The determined concentration range is equal to 10^{-2} to 10%. The method of sodium and potassium determination in magnesium alloys by the method of flame photometry with subsequent photoelectrical registering of the spectrum was carried out. (auth)

22038 SPECTROCHEMICAL ANALYSIS OF SOME PURE METALS. E. V. Lifshitz, V. F. Ercko, N. I. Bugayeva, and L. N. Mosova (Inst. of Physics and Technology, Academy of Sciences, Ukrainian S.S.R., Kharkov). Ukrain. Fiz. Zhur., 6: 846–50(1961). (In Russian)

Some methods of spectrochemical analysis of pure metals are considered. Manganese, chromium, beryllium, nickel, cobalt, molybdenum, zinc, iron, zirconium, and silicon were analyzed for the contents of from 7 to 20 impurities. The impurity concentrations varied from 10^{-1} to 10^{-4}%. The accuracy of the determination was 10 to 20%. The following methods were used to increase the sensitivity; fractionational evaporation in the direct current arc, globule arc, enrichment on evaporational installation, and chemical methods of concentration of impurities. (auth)

22039 THE QUESTION OF THE DETERMINATION OF SILICON IN ALUMINUM–SILICON ALLOYS BY X-RAY FLUORESCENCE ANALYSIS. Franz Lihl and Johann Fischhuber (Technischen Hochschule, Vienna). Z. Metallk., 53: 186–9(Mar. 1962). (In German)

Investigations on the application of x-ray fluorescence analysis for the quantative determination of Si in Al-Si alloys show that the measured number of impulses is not only a function of the Si content, but is also dependent on the formation of the Al-Si eutectic and on the size of the primary Si crystals in hypereutectic alloys. In order to make a clear statement on the Si content of such alloys, microscopic investigations should be made parallel to the measurements of the Si fluorescence intensity. Apart from the personal factor involved in the interpretation of micrographs, the x-ray fluorescence method is too complicated to determine the Si content in Al-Si alloys. Knowing the composition of Al-Si alloys it is possible to draw conclusions about the formation of the Al-Si eutectic and consequently about the rate of refining from the measured number of impulses. (auth)

22040 EXTRACTION DETERMINATION OF Ti IN STEEL AS A PHOSPHORO–TITANO–MOLYBDENUM COMPLEX. Yu. F. Shkaravskii (Inst. of General and Inorganic Chemistry, Academy of Sciences, Ukrainian SSR). Zavodskaya Lab., 28: 265–6(1962). (In Russian)

Photometric determination of Ti as phosphoro-titano-molybdenum is achieved by preliminary extraction of phosphoro-molybdenum by butyl acetate. Admixtures of Nb and V interfere with the extraction and Fe^{3+} weakens the color. The sensitivity of the process is 2 to 3γ Ti in 25 ml; the extraction time is 1.5 hours. (tr-auth)

22041 COMPLEXOMETRIC DETERMINATION OF RARE EARTHS AND THORIUM. S. P. Onosova (Kirov Polytechnic Inst., USSR). Zavodskaya Lab., 28: 271–3 (1962). (In Russian)

A method of rare earth determination by titrating saturated β trilon with nickel chloride and murexide at pH ~ 10 is described. The method is also effective for determining Th with raw earths. The results obtained with the method are tabulated. (R.V.J.)

22042 DETERMINATION OF SMALL AMOUNTS OF CERIUM IN IRON AND STEEL. I. E. Lev and M. S. Kovtun (Dnepropetrovsk Metallurgical Inst., USSR). Zavodskaya Lab., 28: 273–4(1962). (In Russian)

Ce oxidation by permanganate in pyrophosphate medium is used in the colorimetric determination of small amounts of Ce in ferrous metals. Ce is separated by oxalate precipitation with lanthanum as a collector. (tr-auth)

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Refer also to abstract 21906.

22043 (AERE-R-4042) THE DETERMINATION OF CHANGES IN FREE ENERGY FOR URANIUM OXIDES USING A HIGH TEMPERATURE GALVANIC CELL. PART I. T. L. Markin and R. J. Bones (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Apr. 1962. 38p.

The oxygen potential, $\Delta\bar{G}_{O_2}$, was determined for uranium oxides with O/U ratios between 2.01 and 2.53 by the measurement of the emf at 500 to 1000° of a high temperature galvanic cell which contained samples of these oxides. The cell employed was of the type: M,MO–electrolyte–uranium oxide. Thermodynamic properties were calculated from the results and the temperature at which UO_{2+x} becomes two phase $UO_{2+x} + U_4O_9$ was estimated. A method for the nondestructive analysis of single-phase UO_{2+x} was proposed. (auth)

22044 (AFCRL-554) THE PREPARATION OF HIGH PURITY RARE EARTH METALS. Scientific Report No. 1. Bernard Love (Research Chemicals. Div. of Nuclear Corp. of America, Phoenix, Ariz.). June 1961. Contract AF19 (604)-7491. 61p. (AD-267102)

A review is given of the preparation of high purity rare earth metals with respect to occurrence of the elements, their recovery and separation, methods of reduction and purification, and analytical problems. The four elements of primary concern are Pr, Eu, Gd, and Lu. The precedures and techniques currently in use for the preparation of these metals in highest purity are considered in greater detail, as are procedures for the preparation of other rare earths which might also be applicable to the four elements considered. 257 references are given. (P.C.H.)

22045 (BMI-1580) THE CHEMICAL REACTIONS OF PuO_2 WITH REACTOR MATERIALS. Stan J. Paprocki, Donald L. Keller, and William M. Pardue (Battelle Memorial Inst., Columbus, Ohio). May 29, 1962. Contract W-7405-Eng-92. 14p.

The chemical reacitivity of PuO_2 with various ceramic and metallic materials was investigated by thermodynamic computations, metallographic examinations, and x-ray diffraction measurements after sintering abutted interfaces at temperatures representative for densification of the nonfissile material. Initial examination of the PuO_2 used showed approximately 10 vol % of an extraneous hexagonal phase, tentatively identified as Pu_2O_3. Sintering in dry hydrogen at 1700°C caused melting of this material. The work showed that PuO_2 is compatible with MgO, the austenitic stainless steels, Inconel, chromium, molybdenum, niobium, and vanadium. Temperatures vary, but in all cases compatibility exists below 2500°F. ZrO_2 and PuO_2 are mutually soluble, while it appears that PuO_2 and Al_2O_3 may form $PuAlO_3$. Titanium and tungsten apparently are not compatible with PuO_2, and Zircaloy-2 reacts badly. On the basis of these results it appears that, while PuO_2 is analogous to UO_2 in some respects, it is slightly less stable chemically than the uranium compound. (auth)

22046 (DC-61-6-13) STUDIES IN THE $MgUO_3$–$MgUO_4$ SYSTEM. R. M. Haag and C. R. Muncy (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). June 5, 1961. Contract AT(11-1)-171. 16p.

Magnesium uranate was prepared by standard solid-state synthetic techniques and decomposition pressures were measured between 1800 and 2500°F. At oxygen contents less than $MgUO_{3.5}$ a solid solution of fluorite structure is found. Above $MgUO_{3.75}$ the orthorhombic magnesium uranate phase is observed. The two phases are in equilibrium in air at 2300°F. The heat of solution of O_2 in the fluorite phase is 45 kilocalories $mole^{-1}$ and the heat of the reaction $MgUO_{3.5} + 0.120_2$ $MgU_{3.75}$ is 83.3 kilocalories $mole^{-1}$ (O_2). (auth)

22047 (GEAP-4006) SODIUM MASS TRANSFER: III. THE APPLICATION OF LIQUID AMMONIA AS A SODIUM LEACHING AGENT. H. W. Alter and P. A. McManus (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Apr. 1962. Contract AT(04-3)-189. 16p.

A technique is presented for liquid ammonia leaching of metallic sodium from corrosion coupons, filter elements, and sodium samples to reveal contaminants and impurities. The advantages of the method in preserving the physical form of corrosion or mass-transfer deposits are demonstrated. A possible application to the determination of trace oxygen in sodium is mentioned. (auth)

22048 (IS-421) SOME PROPERTIES OF RARE EARTH–NITRILOTRIACETATE COMPLEXES. Samuel Charles Levy and Jack E. Powell (Ames Lab., Ames, Iowa). Feb. 1962. Contract W-7405-eng-82. 76p.

The stability constants of the 1:1 and 1:2 rare-earth-NTA (nitrilotriacetate) complexes were measured at 10, 20, 30, and 40°C at an ionic strength of 0.10. The thermodynamic functions ΔF^0, ΔH^0, and ΔS^0 were calculated for the 1:1 and 1:2 rare-earth-NTA complexes from the temperature dependence of the stability constants. It was found that the main driving force for chelation was a favorable entropy change. The solid 1:1 rare-earth-NTA chelates were prepared at temperatures ranging from room temperature to 100°C. Analyses were done on all the chelates to determine their composition (waters of hydration), and thermal decompositions were done on the various hydrates found. The solubility of each hydrate of the rare-earth-NTA chelates was measured at 25 and 60°C. Analysis of the solids in equilibrium with the saturated solutions indicated the most stable hydrate at each of these temperatures. (auth)

22049 (NBS-C-488(Sect. 5)) AN ULTRAVIOLET MULTIPLET TABLE. Finding List for Spectra of the Elements Molybdenum to Lanthanum (Z = 42 to 57); Hafnium to Radium (Z = 72 to 88). Charlotte E. Moore (National Bureau of Standards, Washington, D. C.). Apr. 6, 1962. 33p.

A finding list is presented for all lines in Section 3 of the Multiplet Table, arranged in order of increasing wavelength and covering the elements molybdenum to lanthanum (Z = 42 to 57) and hafnium to radium (Z = 72 to 88). (M.C.G.)

22050 (NP-11764) ISOTOPIC EXCHANGE BETWEEN Cu–Zn ALLOYS AND Zn^{++} IONS IN SOLUTION. J. Danon and M. Grinberg (Rio de Janeiro. Centro Brasileiro de Pesquisas Fisicas). 1962. 9p. (Notas de Fisica Vol. IX, No. 3, p.35-42).

Results from the isotopic exchange between Zn^{++} ions in solution and copper–zinc alloys of various compositions are indicated and a tentative explanation presented. The experiment indicates no activity until 67 wt % zinc (the epsilon phase with 12 disordered sites). The isotope exchange is increased for the eta phase up to pure zinc. The equilibrium diagram is presented for the copper–zinc alloys. (N.W.R.)

22051 (ORNL-TM-256) CHEMICAL EFFECTS OF HIGH EXPLOSIVE SHOCK WAVES ON VARIOUS COMPOUNDS WHICH OCCUR IN THE GNOME CONTAINMENT MEDIUM. W. D. Bond (Oak Ridge National Lab., Tenn.). May 4, 1962. Contract [W-7405-eng-26]. 7p.

The chemical effects of the action of high explosive shock pressures on NaCl, $CaSO_4$, $MgSO_4$, and polyhalite ($K_2SO_4 \cdot MgSO_4 \cdot 2\ CaSO_4 \cdot 2\ H_2O$) were extremely small. Alkalinity measurements of the solids showed that up to 0.5% decomposition of polyhalite occurred. The decomposition of all other solids was <0.01%. It is not known whether the decomposition was a result of straight decomposition by the shock heat or a result of hydrolysis by traces of moisture in the samples when shock heated. (auth)

22052 (ORNL-TM-258) A STUDY OF THE VISCOSITY OF THORIA SOLS. E. Sturch (Oak Ridge National Lab., Tenn.). June 13, 1962. Contract [W-7405-eng-26]. 18p.

In a preliminary investigation, effects of aging, shear rate, thoria concentration, and nitrate concentration on the viscosity of carefully prepared sols of oxalate ThO_2 dispersed in dilute HNO_3 solutions by the sol-gel process were studied. The ThO_2 sols were non-Newtonian, thixotropic, and rheopectic. The viscosity increased with relative age at low, constant rates of shear; the effect decreased as rates of shear increased and reversed at high shear rate. Equilibrium viscosities were approached with aging for each shear rate whether rates of shear were increased step-wise or decreased. Viscosities increased sharply with increasing NO_3^-/ThO_2 mole ratios at all rates of shear. (auth)

22053 (TID-15827) ELECTROLYTIC SOLUTIONS. Annual Progress Report. Jerry Braunstein (Maine. Univ., Orono). May 1, 1962. Contract AT(30-1)-2873. 19p.

Potentiometric measurements of the association constants of Cd^{2+} with Br^- or I^- in molten equimolar $NaNO_3$-KNO_3 were carried out and the solvent effect was investigated. Transference numbers in molten salt and

concentrated aqueous electrolyte solutions were measured. (M.C.G.)

22054 (TID-15918) A NOVEL HIGH TEMPERATURE INFRA-RED CELL. Technical Report No. III. F. A. Olson and G. C. Anderson (Utah. Univ., Salt Lake City. Inst. of Metals and Explosives Research). Apr. 30, 1962. For Oak Ridge National Lab., Tenn. Contract W-7405-Eng-26, Subcontract 3003. 15p.

A platinum grid cell which fixes a layer of solid material in a vertical position, maintains the sample at a desired raised temperature, allows gases to readily diffuse through and absorb on the material, and allows measurement of the average sample temperature is justified and described. Absorption and emission spectra of two silicon gels are shown to illustrate the spectra this technique gives, and the small amount of radiation emitted at moderate temperatures. (auth)

22055 (TID-16027) CARBONATE COMPLEXES OF THE LIGHTER LANTHANIDES. Howard S. Sherry and Jacob A. Marinsky (Buffalo. Univ.). [1961]. Contract AT(30-1)-2269. 17p.

Distribution of the lighter lanthanides between Dowex I-X8 (carbonate form) and K_2CO_3 solutions was studied as a function of carbonate concentration in order to elucidate their complexing behavior in the presence of an inorganic ligand. Elution chromatography was employed using radioactive isotopes of Ce, Pr, Nd, Pm, Sm, and Eu to facilitate the investigation. The distribution of tracer S^{35} in the form of $S^{35}O_4^{2-}$ between Dowex I-X8 and K_2CO_3 solutions was studied to determine the effect on the system of imbibed electrolyte and changing internal and external activity coefficients. Analysis of the data indicates imbibement and activity coefficient corrections are negligible over the concentration range covered. Distribution coefficients were measured over the concentration range of 0.37 to 2.60 molal K_2CO_3. Over this region a logarithmic plot of the distribution coefficient versus K_2CO_3 molality results in straight lines for all the lanthanides that were studied, indicating the presence of stable complex anions in solution. These trivalent rare earths may be classified into two groups. Group one, consisting of Eu and Sm, is characterized by a slope of –3.0 and group two, consisting of Pr, Nd, and Pm by a slope of –2.5. Analysis of these results indicates that the complexes of group one and two are of the form $[M(OH)(CO_3)_4]^{6-}$ and $[M(CO_3)_4]^{5-}$, respectively. (auth)

22056 (TID-16120) COMPLEX ION FORMATION IN FUSED SALTS. Yearly Progress Report, June 1, 1961–May 31, 1962. Reed F. Riley (Brooklyn. Polytechnic Inst.). Contract AT(30-1)-2747. 13p.

A research project is described for establishing which transition metal ion species exist in molten cyanide eutectics and molten salts to which cyanide ion has been added and determine formation constants. Instrumentation developed for the study is described, and some spectrophotometric studies of $K_2Ni(CN)_4$ in the 4 eutectics (LiK)NO_3, (Na,K)NO_3, (Li,K)Cl, and (K,Ag)CN are reported. (T.R.H.)

22057 (UCRL-9987) STEADY-STATE DIFFUSION IN TERNARY GAS MIXTURES (thesis). Richard W. Getzinger (California. Univ., Berkeley). Jan. 17, 1962. Contract W-7405-Eng-48. 71p.

The Stefan diffusion-tube approach was utilized to experimentally determine the rate of mass transfer in three ternary systems in which two gases were simultaneously diffusing into a third stagnant gas. Constant evaporating binary liquid mixtures were used. The experimentally determined values were compared with the quantities predicted by the Gilliland, or exact, solution of the Stefan-Maxwell equations. Similar comparisons were made with several approximate sets of equations from the literature for typical experimental runs. Results of these comparisons indicated that: unless the interacting influence of the two diffusing gases upon each other is considered, any predictive method will be seriously in error; and the validity of the Stefan-Maxwell equations was established under experimental conditions more stringent than any that were employed previously. These results, together with earlier data for stagnant gas mixtures, provide some proof of the applicability of the Stefan-Maxwell equations to diffusion in complex, multicomponent, gas systems. (auth)

22058 (UCRL-10108) A STUDY OF THE KINETICS OF THE REACTION H + O_2 BY PARAMAGNETIC RESONANCE (thesis). Norman Marvin Edelstein (California. Univ., Berkeley. Lawrence Radiation Lab.). Apr. 1962. Contract [W-7405-Eng-48]. 75p.

The gas-phase reaction of H atoms with O_2 was studied as a function of the total pressure and of the partial pressure of O_2. An electron spin resonance spectrometer was used to analyze for the relative steady-state concentration of the H atoms in a flow system. In order to determine the effect of heterogeneous recombination of H atoms on the walls of the quartz reaction tube, the disappearance of H atoms in an H atom–H_2 system and in an H atom–H_2–argon system was also studied. The experimental results were explained by a modified diffusion equation. The recombination coefficient γ for H atoms was determined and the value found was $1.8 \pm 0.7 \times 10^{-5}$. The experiments on the H atom–O_2 reaction showed that the rate of decay of the H atoms was inversely proportional to the total pressure. The rate constants for this reaction were calculated from the experimental data by the addition of an extra term to the modified diffusion equation. The following mechanism was proposed to explain the experimental results: $H + O_2 \xrightarrow{k_a} HO_2^*$, $HO_2^* \xrightarrow{k_b} H + O_2$, $HO_2^* + \text{Wall} \xrightarrow{k_w} \frac{1}{2}O_2 + \text{Wall}$, $H + HO_2 \xrightarrow{k_d} 2OH$, and $H + OH + M \xrightarrow{k_f} HOH + M$. On the assumption of steady-state conditions for HO_2^*, OH, and HO_2, this mechanism gives, for the disappearance of H atoms, $-d(H)/dt = 4k_a k_w (H)(O_2)/k_b$. At the pressures used k_w is inversely porportional to the total pressure, and the lifetime of HO_2 ($1/k_b$) was calculated to be $5 \pm 2 \times 10^{-10}$ sec. (auth)

22059 (UCRL-10135) KINETIC STUDIES OF THE REACTIONS OCCURRING BETWEEN TUNGSTEN AND GASES AT LOW PRESSURE AND HIGH TEMPERATURES (thesis). Harlan Urie Anderson (California. Univ., Berkeley. Lawrence Radiation Lab.). Apr. 1962. Contract W-7405-eng-48. 141p.

Oxygen, nitrogen, and nitric oxide gases were passed through a system consisting of a tungsten filament, an ion gauge, and a mass spectrometer. The ion gauge recorded total pressures and the spectrometer recorded partial pressures of O_2, N_2, NO, CO, CO_2, and H_2O. From the way these pressures changed with filament temperature, the rates of conversion of O_2 to volatile tungsten oxides and O, and of NO to volatile tungsten oxides N_2, O_2, and O were computed. The time rate of resistance change in the filament was used to compute the rate of conversion of tungsten to tungsten oxides. The filament temperatures ranged from 1950 through 2600°K and gas pressures ranged from 10^{-8} to 10^{-6} atm. For the tungsten-oxygen reaction, the rates of tungsten and oxygen loss were found to depend upon oxygen atom concentration on the surface. The rate of oxide formation depends upon oxygen pressure to the 1 to 1.5

power, depending upon the concentration of oxygen atoms on the surface. The reaction rate at constant oxygen pressure decreases with increasing temperature. For calculational purposes, the tungsten oxygen gas molecules were assumed to be WO_3 only, though WO_2 and WO are other possible products. The apparent activation energy for the formation of WO_3 decreases from 14 to –20 kcal/mole as the concentration of oxygen atoms decreases, because of the competing processes of oxygen molecule desorption from the surface. The rate of reaction of nitrogen with tungsten was found to be less than could be measured under the conditions of this study. The rate of decomposition of nitric oxide was found to depend upon the number of adsorption sites available on the surface, and the rate is controlled by the adsorption of a molecule on a site. The over-all rate decreased with increasing pressure and had an activation energy of 35.2 kcal/mole. The rate of tungsten loss at constant nitric oxide pressure was found to increase with increased temperature. The apparent activation energy for the process increased from 0 to about 50 kcal/mole as pressure decreased. Atomic oxygen was evolved from the tungsten filaments at measurable rates above 2000°K for both the O_2 and the NO reactions. Tungsten can be made carbon-free by heating it in pressures of oxygen near 10^{-8} atm for 20 to 50 hours. Equations were derived to describe the rates of tungsten oxide evolution and monatomic oxygen formation as functions of temperature and of pressure of O_2 or of NO. (auth)

22060 (AEC-tr-4460) JOURNAL OF INORGANIC CHEMISTRY. Translation of Zhurnal Neorganicheskoi Khimii, 3: No. 12, 2593-2810(1958). 293p. (PST-Cat.-382).

A cover-to-cover translation of Zhurnal Neorganicheskoi Khimii (Journal of Inorganic Chemistry), Vol. 3, No. 12 is presented. Separate abstracts were prepared for 11 of the 35 papers. (M.C.G.)

22061 (AEC-tr-4460(p.9-13)) ELECTRON-DIFFRACTION INVESTIGATIONS OF THE STRUCTURE OF MOLECULES OF CESIUM HALIDES. P. A. Akishin and N. G. Rambidi. Translated from Zhur. Neorg. Khim., 3: 2599-2602(1958).

An electron-diffraction study was made of the structure of the molecules of cesium halides in the vapor state. The electron-diffraction data obtained on the interatomic distances in the molecules were in good agreement with values established by microwave spectra. The results of this study confirmed the data of Miller and Kusch that no noticeable amounts of dimer molecules are present in vapors of cesium halides. (auth)

22062 (AEC-tr-4460(p.14-32)) SEPARATION AND PURIFICATION OF TANTALUM AND NIOBIUM BY DISTILLATION OF THEIR PENTACHLORIDES. [PART] II. L. A. Nisel'son. Translated from Zhur. Neorg. Khim., 3: 2603-17(1958).

The separation of tantalum and niobium compounds by distillation is discussed, and theoretical calculations are presented for tantalum and niobium chlorides. The necessity of the absence of compounds containing oxygen in the distilled chlorides is shown. It was found that this can be achieved by additional chlorination of the initial chlorides with carbon tetrachloride or thionyl chloride, under pressure. Experiments were performed on the distillation of mixtures of chlorides containing various amounts of tantalum, niobium, and accompanying impurities. The experiments carried out in a sieve-plate column confirmed calculations and assumptions concerning the effectiveness of separation and purification by distillation. (auth)

22063 (AEC-tr-4460(p.37-47)) AMPEROMETRIC INVESTIGATIONS OF THE PRECIPITATION REACTIONS OF URANYL IONS WITH LITHIUM FERROCYANIDE. G. A. Kleibs. Translated from Zhur. Neorg. Khim., 3: 2621-9 (1958).

The precipitation reaction of uranyl ions by ferrocyanide ions in the presence of lithium ions was studied by amperometric titration. It was found that, depending on the conditions of precipitation, normal uranyl ferrocyanide $(UO_2)_2[Fe(CN)_6]$ and the double salts $5(UO_2)_2[Fe(CN)_6] \cdot Li_4[Fe(CN)_6]$ and $5(UO_2)_2[Fe(CN)_6] \cdot 2Li_4[Fe(CN)_6]$ are formed. Both double salts dissolve incongruently. (auth)

22064 (AEC-tr-4460(p.70-4)) HEATS OF FORMATION OF URANYL CHLORIDE AND URANIUM MONOXYTRICHLORIDE. S. A. Shchukarev, I. V. Vasil'kova, N. S. Martynova, and Yu. G. Mal'tsev. Translated from Zhur. Neorg. Khim., 3: 2647-50(1958).

The heat of solution of $FeCl_3$ in a 2% HCl aqueous solution at 25°C and a dilution of 1 : 1760 was determined. Its heat of formation in the same solution was calculated. The heats of solution of UCl_4, UO_2Cl_2, and $UOCl_3$ in a solution containing 0.5% $FeCl_3$ and 2% HCl were determined. The standard heats of formation from the elements of UO_2Cl_2 and $UOCl_3$ were calculated to be –301.9 and –283.4 kcal/mole, respectively. The heat of formation of $UOCl_3$ by the reaction $\frac{1}{2}\ UCl_4 + \frac{1}{2}\ UO_2Cl_2 - 6.9 \rightarrow UOCl_3$ was calculated. (auth)

22065 (AEC-tr-4460(p.75-8)) THE HEATS OF FORMATION OF URANYL BROMIDE, URANIUM BROMIDE AND MONOXYTRIBROMIDE. S. A. Shchukarev, I. V. Vasil'kova, and V. M. Drozdova. Translated from Zhur. Neorg. Khim., 3: 2651-3(1958).

The heats of solution of UO_2Br_2 and $UOBr_3$ in a solution containing 0.5% $FeCl_3$ and 2% HCl were determined. The standard enthalpies of formation of these compounds were calculated. (auth)

22066 (AEC-tr-4460(p.89-93)) DEGREES OF OXIDATION OF RUTHENIUM IN NITROSO ACID COMPOUNDS. O. E. Zvyagintsev and A. Kurbanov. Translated from Zhur. Neorg. Khim., 3: 2662-5(1958).

The step-wise oxidation of ruthenium and its nitroso acid compounds by potassium permanganate was studied. The oxidation curves of the nitroso compounds showed four potential leaps corresponding to the oxidation of ruthenium. Ruthenium tetroxide was the final oxidation product. The existence of the following states of oxidation of ruthenium was established: I, II, III, IV, VI, and VIII. (auth)

22067 (AEC-tr-4460(p.157-62)) THERMOGRAPHIC INVESTIGATION OF THE DECOMPOSITION OF FORMATES OF THE CERIUM GROUP RARE-EARTH ELEMENTS. M. N. Ambrozhii and Yu. A. Osipova. Translated from Zhur. Neorg Khim., 3: 2716-20(1958).

Decomposition thermograms of La, Ce, Pr, Nd, and Sm formates are given. It was established that the thermal decomposition of La and Ce formates proceeds in two stages, with formation of intermediate products of indefinite composition. The thermal decomposition of Pr, Nd, and Sm formates produced directly their respective oxides with the evolution of CO. (auth)

22068 (AEC-tr-4460(p.223-7)) STUDY OF THE SYSTEM URANYL NITRATE–8-OXYQUINOLINE–WATER BY THE SOLUBILITY METHOD. A. E. Klygin and N. S. Kolyada. Translated from Zhur. Neorg. Khim., 3: 2767-70(1958).

The solubility of 8-oxyquinoline at 25°C in the pH range 4 to 11 was studied and the dissociation constants were determined. The solubility of uranyl oxyquinolate was

studied in solutions of various pH. The solubility product was calculated from these data to be $[1.9 \pm 0.5] \times 10^{-29}$ at 25°C. (auth)

22069 (AEC-tr-4460(p.257-63)) EFFECT OF Co^{60} γ-RADIATION ON AQUEOUS SOLUTIONS OF TIN AND TITANIUM SALTS. L. P. Sidorova, A. V. Zimin, and M. A. Proskurnin. Translated from Zhur. Neorg. Khim., 3: 2793-7(1958).

It was established that when 10^{-2}M solutions of Sn^{2+} in H_2SO_4 are irradiated, the yield of H_2 is independent of the concentration of the acid in the range 1 to 4N. The yield was 0.36 to 0.40 molecules per 100 ev. Introduction of Fe^{3+} into the solutions did not materially affect the hydrogen yield. It was found that reduction of $Sn(OH)_2$ suspensions to metallic tin is more extensive in weakly alkaline than in weakly acid media. It was established that in 10^{-2} and 0.1M solutions of Ti^{3+} in HCl, water radiolysis is 5.0 molecules/100 ev, and in H_2SO_4 it is 4.2 molecules/100 ev. (auth)

22070 (AEC-tr-4460(p.269-73)) INTERACTION OF SEMI-BURNED DOLOMITE WITH STRONTIUM IONS IN AQUEOUS SOLUTIONS. S. A. Voznesenskii, V. F. Bagretsov, and V. V. Pushkarev. Translated from Zhur. Neorg. Khim., 3: 2801-4(1958).

The precipitation of microamounts of strontium by filtering their solutions through columns of semi-burned dolomite was studied at room temperature. It was found that when the initial solution has pH ≤ 5.0 the strontium sorption becomes constant soon after the beginning of filtration, and under the experimental conditions it depends on the time of contact between the solution and the dolomite. When a solution of strontium in 1N NH_4OH was filtered, the sorption became constant after much more prolonged filtration. In 1N NaOH the sorption gradually decreased to zero. (auth)

22071 (AEC-tr-4460(p.276-7)) THE COMPOUNDS OF BERYLLIUM OXYACETATE WITH METHYL AMINE. A. I. Grigor'ev and K. N. Semenenko. Translated from Zhur. Neorg. Khim., 3: 2806-(1958).

The preparation of $Be_4O(CH_3COO)_6 \cdot 4\ CH_3NH_2$ was carried out. X-ray studies were made. The polythermal decomposition curve is given. (M.C.G.)

22072 (AEC-tr-5125) A CONTRIBUTION TO THE CHEMISTRY OF THE TUNGSTATES. Inge Rabes and Rudolf Schenck. Translated from Z. anorg. Chem., 259: 201-19(1949). 30p.

Results of studies on the isothermal reductive degradation of WO_3 and of the tungstates are given. The oxide stage between WO_3 and WO_2 has the composition W_3O_8. The blue-violet compound sublimes at high temperatures and forms fine fibers which condense into a mat resembling a glass-wool plug. The saturation limit of the $NaWO_3$ mixed crystals for WO_3 can be established by means of isothermal analysis through reductive degradation with CO. Metallic silver reduces WO_3 to Ag_2WO_4 and W_3O_8 at high temperatures. The reduction of tungstates by CO can go in two different directions, according to whether stable or metastable reduction products are formed. In constructing a spacial isotherm model from two metallic components and oxygen it is convenient to use perpendicular or triangular coordinates: mole fraction of x (M or M_2) for $M_1 + M_2 = 1$; y = the number of oxygen atoms per metal atom; and the composition of the gas phase = volume percent of CO_2 in the $CO_2 + CO$. In many cases the space model can be constructed from the corresponding, individual isotherms of the mixtures. Plane projections of the models are given for the CO–W–O and Ni–W–O systems. (P.C.H.)

22073 (AEC-tr-5167) ON THE REDUCTION OF EUROPIUM SESQUIOXIDE AND THE PREPARATION OF EUROPIUM MONOXIDE. Jean-Claude Achard. Translated by J. R. Miller (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati) from Compt. rend., 250: 3025(May 2, 1960). 7p. (TM-62-6-3)

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract no. 15634.

22074 (NP-tr-879(Pt.I)) SOME PROPERTIES OF TANTALUM PENTOXIDE. PART I. A. V. Lapitskii, Yu. P. Simanov, K. N. Semenenko, and E. I. Yarembash. Translated by J. M. Crabtree (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.) from Vestnik Moskov. Univ., 9: No. 3, Ser. Fiz.-Mat. i Estestven. Nauk, No. 2, 85-9(1954). 8p.

The dehydration of hydrated tantalum pentoxide was studied in the temperature range 25 to 450°C. A possible region of existence of the tantalic acid with composition $H_7[Ta(TaO_4)_4]$ was determined using a continuous weighing balance. The polymorphic changes of tantalum pentoxide were studied by thermographic and x-ray analysis. The parameters of two modifications of tantalum pentoxide were determined and indexed in a rhombic lattice. The existence of a tantalic acid with the composition $H_{13}[Ta(TaO_4)_4]$ is suggested. (auth)

22075 (NP-tr-879(Pt.II)) SOME PROPERTIES OF TANTALUM PENTOXIDE. PART II. Yu. P. Simanov, A. V. Lapitskii, and E. P. Artamonova. Translated by J. M. Crabtree (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.) from Vestnik Moskov. Univ., 9: No. 9, Ser. Fiz.-Mat. i Estestven. Nauk, No. 6, 109-13(1954). 9p.

Three new modifications of tantalum pentoxide were obtained and the parameters of the basic lattices determined. The modification obtained and characterized as hexagonal was formed by heating at 800°C. The rhombic modification was obtained by heating metallic tantalum to 1100°C. A rhombic modification obtained as needles by heating tantalum pentoxide to 920°C in air is apparently unstable. The conditions for the interconversion of the modifications were also studied. (P.C.H.)

22076 DETERMINATION OF ISOTOPE EFFECTS BY "DOUBLE LABELING" OXIDATION OF D-GLUCOSE WITH IODINE. Horace S. Isbell, Lorna T. Sniegoski, and Harriet L. Frush (National Bureau of Standards, Washington, D. C.). Anal. Chem., 34: 982-4(July 1962).

A simple method is presented for determining isotope effects by the simultaneous use of two different isotopes in a compound undergoing reaction. Mixed with the compound containing the functional isotope (at or near the center of the reaction) is the same compound bearing the second (reference) isotope placed at a point, remote from the reaction center, where it will have little or no effect on the rate of reaction. The effect of the functional isotope on the reaction rate is measured by changes in the ratio of the two isotopes as the reaction proceeds. Carriers can be used, and quantitative separation of the materials is unnecessary because the determination depends on the ratio of the isotopes. The method is applicable to a variety of chemical and biological reactions. It is illustrated by a study of the oxidation, by iodine in alkaline solution, of isotopically labeled D-glucose-1-t, 6-C^{14} and D-glucose-1-C^{14}, 6-t. (auth)

22077 AN IMPROVED METHOD FOR DISSOLUTION OF URANIUM TETRAFLUORIDE. W. M. Wise, H. R. Soehnlin, and C. H. McBride (Mallinckrodt Chemical Works, Saint Charles, Mo.). Anal. Chem., 34: 1035(July 1962).

Dissolution of UF_4 in a mixture of $(NH_4)_2SO_4$ and H_2SO_4 and boric acid is described. For large-sized samples, addition of boric acid appreciably hastened dissolution, and a 15-gram sample was dissolved in 30 min in quartz glassware. The cooled melt is soluble in distilled water. (M.C.G.)

22078 THE FLUOROXALATES OF TETRAVALENT URANIUM. I. V. Tananaev and G. S. Savchenko. Atomnaya Energ., 12: 392-6(May 1962). (In Russian)

The properties of the fluorides and oxalates of many metals present marked similarities: the simple salts are insoluble while the complex ions have identical structure, as e.g., $[MeF_8]^{3-}$ and $[Me(C_2O_4)_3]^{3-}$. Therefore, on the basis of known, slightly-soluble U oxalate and fluoride the existence of a compound of tetravalent U, containing both F and oxalate ions, was anticipated on the basis of the equation: $UF_2^{2+} + 2C_2H_4^{2-} \rightarrow UF_2C_2O_4$. However, in view of the fact that the F ions possess a different replacement ability, the direct interaction of oxalic acid and UF_4 was investigated, using the stable $UF_4 \cdot 2\frac{1}{2}H_2O$ for the study. Depending on the experimental conditions used, such as heating up to 100°C with a saturated solution of oxalic acid or melting the fluoride together with $H_2C_2O_4 \cdot 2H_2O$ followed by heating to 200°C, the following fluoroxalates were obtained: (a) $(UF_2)C_2O_4 \cdot 1\frac{1}{2}H_2O$ and (b) $(UF_2)(C_2O_4)_2$. The U tetrafluoride is not transformed completely into the pure oxalate by these reactions. (TTT)

22079 STUDY OF THE FORMATION OF URANIUM TETRAFLUORIDE IN SOLUTION. I. V. Tananaev and G. S. Savchenko. Atomnaya Energ., 12: 397-403(May 1962). (In Russian)

In spite of the importance of UF_4 in several fields, its mechanism of formation and its structure and properties are not sufficiently well known; for this reason the system $U(SO_4)_2 - HF - H_2O$ was closely investigated. Metallic U containing only small amounts of impurities was used for the preparation of the starting solution of $U(SO_4)_2$. The three-component system was investigated by the use of spectrophotometric and pH measurement techniques. It was found that the reaction takes place in 2 stages, forming first UF_2^{2+} ions, then the slightly soluble $UF_4 \cdot 2\frac{1}{2}H_2O$. X-ray-diffraction studies indicated that the latter compound exists in cubic and monoclinic modifications having different solubilities. The $UF_4 - HF - H_2O$ system containing up to 80% HF includes 3 solid phases: the monoclinic $UF_4 \cdot 2\frac{1}{2}H_2O$, the water-free UF_4, and the $UF_4 \cdot 4HF$. The solubility of UF_4 at 25°C varies within narrow limits from 0.008 to 0.045% as the HF content of the system is changed from 0 to 80%. (TTT)

22080 DIFFERENCES IN THE CATALYTIC ACTIVITY OF NICKEL, PLATINUM AND PALLADIUM AS OBSERVED IN THE ISOTOPIC EXCHANGE REACTION OF PARAXYLENE WITH DEUTERIUM OXIDE. Kozo Hirota and Tomiko Ueda (Osaka Univ.). Bull. Chem. Soc. Japan, 35: 228-32 (Feb. 1962). (In English)

It was confirmed that nickel can exchange catalytically only hydrogen atoms of methyl groups of paraxylene with deuterium oxide, irrespective of the method of preparation, while platinum and palladium can exchange hydrogen atoms of both methyl groups and benzene ring under similar experimental conditions. It was found that the catalytic activity of nickel becomes similar to that of platinum and palladium if nickel is supported on alumina, but remains unchanged if it is supported on silica or kieselguhr. (auth)

22081 A KINETIC STUDY OF THE ISOTOPIC EXCHANGE OF INDIUM BETWEEN THE INDIUM ION AND ITS N-2-HYDROXYETHYLETHYLENEDIAMINE-N,N',N'-TRIACETATE COMPLEX IN AN ACID SOLUTION. Kasuo Saito and Michiko Tsuchimoto (Tokyo Univ.). Bull. Chem. Soc. Japan, 35: 367-70(Mar. 1962). (In English)

The isotopic exchange of indium between the indium ion and its EDTA-OH complex was kinetically studied in an acid solution using In^{114m} as tracer. Separation of the indium ion from its EDTA-OH complex was satisfactorily carried out with 8-quinolinol (oxin) at a pH about 3, and no appreciable heterogeneous exchange was observed between the precipitate and the solute. The exchange constant R was proportional to the concentration of the complex, the hydrogen ion, and the ions such as dihydrogen citrate, but was independent of the concentration of the indium ion. It was affected by the ionic strength to a less extent, and the Arrhenius activation energy was 11 kcal per mole. A plausible reaction mechanism was postulated on the basis of the kinetic data. The dissociation of the protonated indium EDTA-OH complex appeared to be the rate-determining step. (auth)

22082 STUDIES ON METAL COMPLEX SPECIES USING AN ANION EXCHANGE RESIN. III. URANIUM(VI)-NITRATE COMPLEX AND ZINC-CHLORIDE COMPLEX. Jun Yoshimura, Hirohiko Waki, and Shingo Tashiro (Kyushu Univ., Fukuoka). Bull. Chem. Soc. Japan, 35: 412-15(Mar. 1962). (In English)

The "indifferent electrolyte-adding" method was applied to the uranyl-nitrate and to the zinc-chloride complexes. A sodium nitrate-sodium perchlorate mixed medium was employed in the former, and a sodium chloride-sodium nitrate medium in the latter. The predominant species of the uranyl-nitrate complex adsorbed from sodium nitrate solutions was $UO_2(NO_3)_3^-$ at the external nitrate concentration of about 2M and $UO_2(NO_3)_4^{2-}$ at the 4 to 6M concentration. The coexistence of the two species may be presumed at 2 to 4M. The principal zinc-chloride complex adsorbed on the resin from the chloride solution of 0.4 to 3M was simply $ZnCl_4^{2-}$, accompanied by a small quantity of $ZnCl_3^-$ in a low ionic strength. On the other hand, the predominant species in the aqueous phase were $ZnCl_3^-$ and $ZnCl_4^{2-}$ for a sodium chloride concentration of 3M, and Zn^{2+} and $ZnCl^+$ for a 0.4M concentration. These results were approximately consistent with those obtained previously in an HCl medium. (auth)

22083 THE INFRARED ABSORPTION SPECTRA OF 1,3,5-TRICHLOROBENZENE, 1,2,4,5-TETRACHLOROBENZENE AND THEIR DEUTERATED DERIVATIVES. Shinnosuke Saëki (Government Chemical Industrial Research Inst., Tokyo). Bull. Chem. Soc. Japan, 35: 442-8 (Mar. 1962). (In English)

The infrared absorption spectra of 1,3,5-trichlorobenzene, 1,3,5-trichlorobenzene-d_3, 1,2,4,5-tetrachlorbenzene, and 1,2,4,5-tetrachlorobenzene-d_2 were observed in a gaseous state from 700 to 300 cm^{-1} with a cesium bromide prism and in a solid state from 300 to 100 cm^{-1} using a grating spectrometer. Furthermore, the spectra in the sodium-chloride region were carefully observed in the ranges where the main absorption bands appear, using a long-path (720 cm), high-temperature cell. On the basis of the results obtained, the assignments of the infrared active normal vibrations of these substances were determined and checked by the product rule. The assignments of the overtone and combination bands were also determined using the assigned frequencies and species of infrared active and Raman active fundamental vibrations. (auth)

22084 HYDROLYSIS OF URANYL. I. BEHAVIOR OF HYDROLYTIC COMPLEXES ON ANEX IN PERCHLORATE

MEDIUM. V. Baran and M. Tympl (Inst. of Nuclear Physics, Czechoslovak Academy of Sciences, Rez). Collection Czechoslov. Chem. Communs., 27: 709-15(Mar. 1962). (In German)

The behavior of solutions of hydrolyzed uranyl on Anex "Dowex 1" in perchlorate medium was investigated. On the basis of the results, it was proved that all hydrolyzed uranyl particles in the solution show only cation characteristics and possess no acid properties. The origin of the adhesion of uranium under the conditions given is to be found in adsorption. (tr-auth)

22085 SELECTIVITY AND IONOPHORESIS OF ION EXCHANGERS. Victor G. Austerweil. Compt. rend., 254: 2558-60(Apr. 2, 1962). (In French)

The selectivity of ion exchangers is designated by the quotient of the ratio of two ions in solution before and after their passage across a mass of exchangers. The method of determining the selectivity is described, and the effects of heat and ionophoresis on this characteristic are discussed. It was shown that the effect of temperature and ionophoresis can be combined in mineral exchangers to measure selectivity. (J.S.R.)

22086 STUDY OF THE CONDITIONS FOR THE PURIFICATION OF METALLIC SAMARIUM AND EUROPIUM. Charlotte Henry La Blanchetais. Compt. rend., 254: 2785-7(Apr. 9, 1962). (In French)

Studies on the preparation of Sm and Eu by the reduction of sesquioxides by La were made. It was shown that the elements prepared in this way without any additional refining contain considerable quantities of protoxide. The low temperature processing of crude Eu by sublimation followed by refusion of the condensate yields a metal containing no chemically detectable EuO. Crude Sm can be refined by refusion under Ar followed by a slow cooling. Sublimation then gives a very pure metal. (J.S.R.)

22087 POLAROGRAPHIC INVESTIGATION OF SOME NIOBIUM COMPLEXES. Robert Emmet Kirby (Univ. of Arizona, Tucson). Dissertation Abstr., 22: 2564(Feb.1962).

A detailed polarographic and kinetic study was applied to some complexes of niobium and tantalum. The polarographic behavior of the first reduction step of the niobium-EDTA complex was thoroughly investigated and found to be a reversible, one electron reduction over the range of pH studied, from 0.3 to 6.0, with a slight amount of irreversibility appearing in the upper pH region due to low buffer capacity of the solution. The half-wave potential varied linearly with pH in three pH regions, indicating the involvement of one hydrogen ion in the pH region from 0.3 to 2; two hydrogen ions from pH 2 to 3.1; and 2.5 hydrogen ions from pH 3.4 to 5.7. The half-wave potential was not affected by EDTA concentration in a well buffered solution. The temperature coefficient of the half-wave potential was -1.3 mv per degree and that of the diffusion current was linearly proportional to the niobium concentration over the concentration range of 0.5 to 1000 μg niobium per ml. A kinetic study showed that the formation of the reducible Nb-EDTA complex consists of two parallel first order reactions with respect to niobium; one Nb-EDTA species depends upon EDTA$^{-\frac{1}{2}}$ $H^{+\frac{1}{2}}$ and the other depends upon $[EDTA]^{-\frac{1}{2}}$ $[H^{+}]^{-\frac{1}{2}}$. An investigation of a similar nature was carried out for the niobium-hydroxyethylethylenediamine triacetic acid complex. A method was described for testing complexing reagents with niobium. The tantalum-EDTA complex was prepared and studied polarographically.

22088 THE DILUTE SOLUTION CHEMISTRY OF ANTIMONY. Kent Hoover Jones (Univ. of New Mexico, Albuquerque). Dissertation Abstr., 22: 2578-9(Feb. 1962).

Solutions of carrier-free Sb^{125} in hydrochloric, sulfuric, and perchloric acids and in water were prepared, and some observations were made concerning the chemical behavior of Sb^{125} in these solutions. These observations consisted of determining the stability of Sb^{125}(III) and Sb^{125}(V) under various conditions, the factors that cause oxidation of Sb^{125}(III) and reduction of Sb^{125}(V), the extent of adsorption and co-precipitation of Sb^{125} from different solutions and with different substances, and the relationship between the behavior of carrier-free Sb^{125} and the behavior of antimony at conventional concentrations. Hydrochloric acid solutions of Sb^{125} were prepared by electrochemically depositing Sb^{125} on copper from a 6N hydrochloric acid solution containing neutron-irradiated tin, dissolving the Sb^{125} in nitric acid, and finally separating the Sb^{125} from copper by use of Dowex-1 anion exchange resin. An over-all yield of greater than 80% of the Sb^{125} in the irradiated tin was obtained from this procedure. Hydrochloric acid solutions of Sb^{125}(V) were prepared directly by this method; Sb^{125}(III) was prepared by boiling these solutions in concentrated hydrochloric acid. Other solutions of Sb^{125} were prepared by evaporating the hydrochloric acid, in which the Sb^{125} was dissolved, either under vacuum or with a stream of dry nitrogen and then dissolving the residual Sb^{125} with the desired solvent. From 50 to 95% of the Sb^{125} was recovered in these experiments. When the evaporation occurred from 10N hydrochloric acid solutions, nearly quantitative yields of Sb^{125}(III) were obtained. Sb^{125}(V) was readily obtained by irradiating the solutions of Sb^{125}(III) with a General Electric H400-Al mercury lamp. Distinguishing between Sb^{125}(III) and Sb^{125}(V) was accomplished by use of an extraction mixture consisting of 8 ml of isopropyl ether, 7 ml of solution 6N in hydrochloric acid and 2.14M in magnesium chloride, and 1 ml of solution 6N in hydrochloric acid and 0.05M in both antimony(III) and antimony(V). To this mixture was added 1 ml of solution containing Sb^{125}; Sb^{125}(V) entered the ether phase and Sb^{125}(III) remained in the aqueous phase. The stability of the two oxidation states of Sb^{125} was measured in different solutions under various conditions. In general Sb^{125}(V) was more stable than Sb^{125}(III). For instance, only in hydrochloric acid in the absence of light and oxygen could Sb^{125}(III) be maintained without oxidation for a long period, whereas stock solutions of Sb^{125}(V) in 2N hydrochloric acid were kept indefinitely without reduction occurring when no special precaution was made to remove light and oxygen. In basic and neutral solutions Sb^{125}(III) was considerably oxidized within 1 hour even in the absence of light. It appears from the data of the stability experiments that both oxygen and light contribute to the oxidation of Sb^{125}(III). Reduction of Sb^{125}(V) occurred mostly in hydrochloric acid solutions and subsequent experiments demonstrated that this reduction was probably due to chloride; the limited amount of reduction in other solutions may have been due to traces of some reducing impurity. A specific study of the reduction of Sb^{125}(V) in hydrochloric acid revealed that the fraction of antimony reduced is increased by increasing the temperature and the hydrochloric acid concentration. Extending this study to carrier amounts of antimony revealed that appreciable reduction does not occur in concentrations above 10^{-4}M, and the study also provided a means of estimating the antimony concentration in the solutions of carrier-free Sb^{125} used in this work. The concentration was estimated in the range of 10^{-6} to 10^{-10}M. Several reducing agents (SO_2, Sn^{2+}, Fe^{2+}, and I^-) were used to compare the reduction of carrier-free Sb^{125}(V) with the reduction of 5×10^{-5}M antimony(V) in various solutions (HCl, H_2SO_4, and $HClO_4$). Very little difference in reduction was observed except with sulfur dioxide in hydrochloric acid in

which case the carrier-free Sb^{125}(V) was more effectively reduced. Iodide was observed to be the most effective reducing agent. Chlorine, bromine, and light from the mercury lamp were all very effective in oxidizing Sb^{125}(III). It was concluded that oxidation by light proceeds indirectly through an unstable intermediate, probably a peroxide. It was shown that carrier-free Sb^{125} is not lost from acid solutions due to adsorption on the walls of Pyrex vessels. A maximum of about 14% is adsorbed on Pyrex in 1 hour from solutions of pH 7.9 to 9.2. A decreasing amount adsorbed as the pH varied from these values. Sb^{125} formed radiocolloids in hydrogen sulfide-hydrochloric acid solutions which could be centrifuged and filtered from solution. Sulfide precipitates quantitatively carried Sb^{125} as also did ferric hydroxide in the middle pH region. Arsenic metal, precipitated by Oxorbent, quantitatively carried Sb^{125}, whereas with no arsenic present the amount of antimony removed from solution by Oxorbent decreased to about 50% as the antimony concentration was reduced to carrier-free Sb^{125}. Essentially no Sb^{125} was carried with silver chloride. The behavior of carrier-free Sb^{125} on Dowex-1 resin was found to be different from that of carrier antimony in at least one respect. With carrier antimony(V) the distribution coefficient in 2N hydrochloric acid is quite low, and after placing antimony(V) in 6N hydrochloric acid on a Dowex-1 resin column, the antimony could be readily eluted with 2N hydrochloric acid. However when carrier-free Sb^{125}(V) in 6N hydrochloric acid was added to the column, it was only effectively eluted with 2N hydrochloric acid after first washing the column with water.

22089 THE APPLICATION OF NUCLEAR MAGNETIC RESONANCE TO THE DETERMINATION OF SOLVATION PROPERTIES OF SELECTED SOLVENTS TOWARD PARAMAGNETIC METAL IONS. Mary Margaret Anderson (Northwestern Univ., Evanston, Ill.). Dissertation Abstr., 22: 2599(Feb. 1962).

The use of nuclear magnetic resonance for the determination of the rates of chemical exchange reactions that are too rapid to be measured by the conventional isotope technique was investigated. The particular type of chemical exchange considered was that of the exchange of molecules coordinated to paramagnetic ions with those of the bulk solution. The phenomenological Bloch equations predict the shape of a nuclear magnetic resonance signal in the absence of chemical exchange. The form of these equations, corrected to account for such exchange, and simplifying assumptions appropriate to the special case of exchange of a nucleus between a paramagnetic site and a diamagnetic site are discussed. The solution of the corrected equations correlates the line width of the nuclear magnetic resonance absorption spectrum of the exchanging nucleus with the rates of chemical exchange and paramagnetic relaxation. Some criteria for determining whether the exchange rate or the paramagnetic relaxation rate is being measured are discussed. The paramagnetic ions investigated are those of the first transition series and Ce^{3+} and Gd^{3+}. The coordinating molecules used were methanol, ethanol, acetate ion, formate ion, and water. The line widths of the nuclear magnetic resonance absorption spectra for the H^1 nucleus were obtained by the direct measurement of the line width on the screen of an oscilloscope calibrated for frequency versus distance. The line widths for the spectra of chemically nonequivalent nuclei were measured separately. The rates of exchange reactions that are slow enough to be determined by this method are those cases predicted by crystal field theory and by other experimental evidence. The rates of such exchanges are those for which the lifetime of the coordinated species lies between 0.01 and 0.0001 second. In cases of more rapid exchange, the determination of the paramagnetic relaxation rate gives the lower limit of the rate of chemical exchange.

22090 MEASUREMENT OF THE DISSOCIATION RATES OF HYDROGEN AND DEUTERIUM. Emmett Albert Sutton (Cornell Univ., Ithaca, N. Y.). Dissertation Abstr., 22: 2607(Feb. 1962).

Using an interferometer and drum camera to measure the density ratio behind an incident shock wave in mixtures of argon and hydrogen, the dissociation rates for two isotopes of hydrogen were measured. Sufficient data were obtained to measure the rate constants for the reaction in a temperature range from 2800 to 4500°K. The relative efficiencies of argon, the hydrogen molecule, and the hydrogen atom in dissociating hydrogen were found for each isotope. The rate constants for the hydrogen molecule and the argon atom as third bodies for association were found to have a simple 1/T dependence. The rate constants for the collision of three atoms causing association were found to be much larger than the other rate constants and to have a more involved temperature dependence. The rate constant for the association of hydrogen where the third body is a hydrogen atom shows a marked change in its rate of decrease at about 3400°K.

22091 MULTIPLE IONIZATION BY HIGH ENERGY ATOMIC COLLISIONS. John Bradley Bulman (Univ. of Connecticut, Storrs). Dissertation Abstr., 22: 2836-7 (Feb. 1962).

A phenomenological theory, developed to account for ionization produced in heavy atom collisions, was extended. The original theory considered eight electrons in the outer shell. Ionization probability curves are given for atoms having from two to seven outer electrons. Comparison with experimental data for nitrogen on argon scattering was made using the five electron curves and agreement was found to be good. An improvement was made in the statistics of the original theory when accounting for the fact that the bombarding atom is singly ionized before collision. The theory was then used to analyze scattering data and present evidence that resonant electron capture is occurring in two different cases. First, better agreement with experimental data was found when considering scattering at a constant angle for different incident ion energies, if the probability of electron transfer was allowed to vary. This electron transfer variation was oscillatory, giving evidence of resonance as a function of the velocity of the incident ion. In the second case monoenergetic beams scattered through various angles were studied. Here again closer agreement with experiment was found when the electron transfer probability was allowed to vary. This variation, also oscillatory, indicated resonant charge transfer as a function of distance of closest approach. Both cases seemed reasonable when compared to experimental evidence of resonant electron transfer and results of the impact parameter method.

22092 VISCOSITY AND DENSITY MEASUREMENTS FOR NORMAL LIQUID HYDROGEN AND VARIOUS ORTHO-PARA MIXTURES. Rayjor W. H. Webeler (Univ. of Cincinnati). Dissertation Abstr., 22: 2839-40(Feb. 1962).

The absence of experimental data in the literature concerning a viscosity difference for normal and equilibrium liquid hydrogen may be attributed to the limited reproducibility of "oscillating disk" measurements in a liquid hydrogen environment. Measurements are given representing the first application of the piezoelectric alpha quartz torsional oscillator technique to liquid hydrogen viscosity measurements. The logarithmic decrement of such a torsional right circular cylindrical crystal is related to the

viscosity coefficient of a surrounding liquid by the relation $\eta\rho = (M^2/S^2)(\Delta - \Delta_0)^2 (F_R/\pi)$. Here η is the viscosity coefficient; ρ is the density of surrounding liquid; $\omega = 2\pi F_R$ (resonant frequency); r_0 is the radius of crystal; and M the mass of crystal. $\Delta = \frac{1}{2}$(energy dissipated/c)/(energy of vibration); Δ_0 is the logarithmic decrement of crystal in vacuum; and S the total surface area of the crystal including end faces; provided that $\lambda^{-1} = (\rho\omega/2\eta)^{-\frac{1}{2}} \ll r$, where λ^{-1} is the thickness of the characteristic boundary layer. The torsional crystal of 0.25 cm radius used for this experiment had a resonant frequency F_R of approximately 39,702 cps providing a λ^{-1} of about 1.6×10^{-4} cm. The crystal was located in an isothermal copper chamber, which in turn was placed within a double Dewar system. A bath of liquid hydrogen in the inner Dewar served only as a cold reservoir, while the pure normal hydrogen gas was condensed into the vacuum-tight copper chamber around the crystal. The latter, highly polished, was suspended at the central strain node so that in vacuum at 14°K it possessed a decrement of 4.7×10^{-7}, as contrasted with 12.5×10^{-3} when immersed in liquid hydrogen. The crystal was electrically connected to one arm of a modified Shearing capacitance bridge, and the decrement was determined from measurement of the crystal resistance at resonance. Suitable filter and preamplification systems of the bridge output signal provided a precision better than 0.2% for relative values of $\eta\rho$. Values of $\eta\rho$ were measured as a function of temperature (below 14.5°K) within selected time intervals, short compared to the half-life of the conversion process. A number of such "sub runs" were taken at different times, hence at different concentrations during the slow conversion process occurring over a 200-hr "run," of which there were three, of essentially identical results. The ortho-para concentration was determined in each "sub run" by measuring the temperature of the triple point; the latter could be determined precisely with reference to a carbon resistance thermometer, since contact of hydrogen ice with the crystal surface resulted in nearly an infinite crystal resistance. The carbon thermometer was calibrated from vapor-pressure measurements using an octoil and mercury manometer system. The absolute temperature measurements are probably correct within 0.01°K whereas temperature differences of 0.003°K could easily be detected. Examination of the first, second, and last "sub runs" clearly indicates that at 39,702 cps the $\eta\rho$ values below 14.5°K for 69% ortho liquid hydrogen are about 4% larger than the corresponding values for 28% ortho liquid hydrogen. As a consequence of the uncertainty in absolute temperature, differences in ortho-para concentration can be determined more accurately than absolute concentration values. The uncertainty in the absolute values of the concentration is ±5% ortho, while the differences in concentration are correct within 2%. Since the density of normal liquid hydrogen at 14°K was previously reported to be approximately 0.4% higher than the corresponding equilibrium density, approximately 3.7% difference in $\eta\rho$ is attributed to differences in η due to ortho-para composition.

22093 PART I: A STUDY OF 1,3 SHIFTS. PART II: THE KINETIC ISOTOPE EFFECT IN THE CHLORINATION OF DIDEUTEROMETHANE. Edwin Lyle Motell (Univ. of Washington). Dissertation Abstr., 22: 3857(May 1962).

The determination of the initiation and the termination products in the free radical induced rearrangement of α-benzyloxystyrene to ω-phenylpropiophenone was undertaken in order to complete a series of investigations on the 1,3 rearrangements of α-alkoxystyrenes to the corresponding ketones. α-Benzyloxystyrene was allowed to rearrange using azo-bis-isobutyronitrile labeled with C^{14} in the cyano groups as a catalyst and the initiation product (β-cyanoisovalerophenone) determined by isotopic dilution techniques. Under the reaction conditions studied, a chain length of 21.3 and an initiator efficiency of 69.6% was observed. Similarly α-benzyloxystyrene, labeled with C^{14} in the benzyl group, was allowed to rearrange and the termination products investigated. It was found that approximately 41% of the termination reaction involves the formation of dibenzyl and that the formation of 1,2,3-triphenylpropane accounts for less than 1% of the termination products. Several experiments are proposed to determine the remaining termination products. Dideuteromethane was chlorinated and the kinetic isotope effect calculated from the results of the mass spectral analysis of the products. The observed value of the isotope effect is given by $k_H/k_D = 1.09\ e^{-1200/RT}$ ($k_H/k_D = 12.2$ at 0°). Models of the activated complexes, obtained from potential energy surface calculations, were used to approximate the frequencies of the activated complexes. Employing these frequencies the isotope effect, predicted on the basis of the theory of absolute rates, was calculated and compared with the observed isotope effect.

22094 RAMAN AND INFRARED SPECTRA OF DEUTERATED PENTABORANE FREQUENCY ASSIGNMENT AND NORMAL COORDINATE ANALYSIS FOR NORMAL AND DEUTERATED PENTABORANE. Sam Ray Coriell (Ohio State Univ., Columbus). Dissertation Abstr., 22: 3865(May 1962).

The Raman spectra of liquid deuterated pentaborane, which was prepared by the catalytic exchange of normal pentaborane and deuterium, were measured. The polarization of the stronger Raman lines was determined. The infrared spectra of gaseous deuterated pentaborane were obtained by using the Perkin-Elmer Model 21 spectrophotometer with NaCl and KBr optics. An assignment of the vibrational frequencies of normal and deuterated pentaborane was made. The A_1 and E (Raman and infrared active) frequencies and all observed B_1 and B_2 (Raman active) frequencies were completely assigned; several of the B_1 and B_2 (Raman active) frequencies were not observed. A normal coordinate analysis was carried out by the G-matrix technique of Wilson. A computational technique was developed which, starting with a trial set of force constants, determines by a method of steepest descents the set of force constants which minimizes the sum of the squares of the percentage error between assigned and calculated frequencies. This procedure was programmed in Fortran for an IBM 704 computer. A potential function with 21 force constants was found which gives an average error of 2.3% between the 32 observed and calculated A_1 and E frequencies. The B_1, B_2, and A_2 frequencies and normal coordinates were calculated from these force constants, and agree fairly well with the observed frequencies in most cases. The statistical entropy of pentaborane, calculated from the assigned frequencies, is in good agreement with the calorimetric entropy. The thermodynamic functions of normal pentaborane were calculated for the temperature range 296 to 2500°K from the assignment. The correlation of normal frequencies in deuterated and non-deuterated molecules is discussed. Such correlations are clarified by consideration of a hypothetical continuous plot of the logarithm of each normal frequency versus the logarithm of mass of the isotopic atom. A plot of this type (calculated from the force constants obtained in the normal coordinate analysis) is given for each symmetry species of pentaborane. The slope of each frequency curve is half the negative of the fraction of the kinetic energy of the normal mode contributed by the isotopic atoms, and lies between 0 and $-\frac{1}{2}$, which is the equivalent of the order rule. A re-

versal rule is proposed which states that near degeneracy of two frequencies of the same species, at an intermediate isotopic mass, will result in an interchange of the role of the isotopic atoms in the associated modes in the deuterated and non-deuterated molecules. Therefore if these two frequencies are arranged by type their order will be reversed. Examples of such reversals in B_2H_6 and B_2D_6 are discussed.

22095 DECOMPOSITION OF CHEMICALLY ACTIVATED ETHYL-D_3 AND ETHYL-D_1 RADICALS. Jerry Hall Current (Univ. of Washington). Dissertation Abstr., 22: 3866(May 1962).

The rate of decomposition of ethyl-d_3 radicals was studied at 195 and 300°K over the pressure range from 0.05 to 3.0 mm. The radicals were formed by the addition of deuterium atoms, which effused through a leak from a Wood-Bonhoeffer discharge tube, to trans-ethylene-d_2. The energized ethyl radicals decomposed by hydrogen or deuterium atom rupture or they were collisionally stabilized. The rate of decomposition was determined relative to the rate of stabilization by complete product analysis. All of the products were analyzed for their deuterium content and the ethylene was analyzed for the cis-ethylene-d_2 isomer. The limiting high pressure rate for hydrogen rupture from energized ethyl-d_3 radicals was determined to be 6.5×10^7 sec^{-1} at 300°K and 2.5×10^7 sec^{-1} at 195°K. The limiting low pressure rate for hydrogen rupture was found to be 2.0×10^7 sec^{-1} at 300°K and 1.0×10^7 sec^{-1} at 195°K. The hydrogen to deuterium rupture ratio was determined from 22 runs to be 1.99 ± 0.39 at 300°K and from 16 runs to be 2.60 ± 0.69 at 195°K for this non-equilibrium reaction system. Experimental error masked an expected pressure dependence of the isotope effect and caused the isotope effect to be unreliable at low pressures. The disproportionation to recombination ratio for ethyl radicals was found in 37 runs to be 0.14 ± 0.04 at 300°K and in 20 runs to be 0.17 ± 0.04 at 195°K. The isotopic H/D disproportionation ratio was determined from a total of 57 runs made at both temperatures to be 1.6 ± 0.4. Helium and deuterium were observed to have one-third to one-half the efficiency of trans-ethylene-d_2 for deactivating energized ethyl-d_3 radicals on a collision per collision basis. Ethyl-d_1 radicals, formed by the addition of deuterium atoms to light ethylene, were observed to decompose by hydrogen rupture at a rate over four times that found for hydrogen rupture from ethyl-d_3 radicals. A large secondary isotope effect of 1.4 per isotopically substituted atom was found between the ethyl-d_1 radicals and the ethyl-d_3 radicals. The theoretical rate was calculated from a Marcus-Rice formulation of the rate constant. The calculations were made on an IBM 709 computer using densities of energy states calculated from harmonic oscillator models. Good qualitative agreement and rough quantitative agreement was found between the various experimental quantities and quantities calculated from a model which has a very loose activated complex (150 cm^{-1} C-C-H bends) with the figure axis rotation active, and which has an energized radical with an active free internal rotation and an active figure axis rotation.

22096 NUCLEAR MAGNETIC SHIELDING IN MOLECULES. Charles William Kern (Univ. of Minnesota, Minneapolis). Dissertation Abstr., 22: 3869(May 1962).

An expression for magnetic shielding in linear molecules, applied here to all nuclei in LiH, BH, NH, BF, HF, LiF, CO, H_2, Li_2, N_2, and F_2, was derived by a suitable choice of vector potential such that Ramsey's excited-state sum is replaced by matrix elements involving only the ground-state wave function. Approximate cancellation of average excitation energies for matrix elements depending upon the angular momentum and the linear momentum operators, leads to good results for the paramagnetic term, and also for the total magnetic shielding, but only for those nuclei atoms bonded to heavier atoms. The chemical shift of the bridge relative to the terminal proton in diborane is discussed in several approximations based on Pople's and on Ramsey's atomic and molecular theories of magnetic shielding, respectively. The analysis, which depends on Yamazaki's twelve electron SCF LC-STO MO wave function, gives the result, generally observed in the H^1 NMR spectra of the higher hydrides, that the bridge protons show resonance at higher fields than do the terminal ones.

22097 A STUDY OF THE RARE-EARTH METAL COMPLEXES. Robert Stanley Kolat (Iowa State Univ. of Science and Tech., Ames). Dissertation Abstr., 22: 3869-70(May 1962).

The solid rare-earth chelates of ethylenediaminetetraacetic acid were examined using thermobalance, infrared and x-ray-diffraction techniques. The lighter members are monohydrates while the heavier members are anhydrous after drying for 12 hours at 110°C. Infrared studies indicated that the light-member chelates have a pentadentate EDTA structure while the remaining rare earths assume a hexadentate configuration. The transition occurs with europium. X-ray-diffraction studies substantiated this structural change. Ionization constant determinations of these acids indicated that a corresponding change does not occur in solution. Examination of the alkali metal salts of these acids indicated that these rare-earth compounds are probably mutually isomorphous. The complex formation constants of the rare earths with the acetate, methoxyacetate, thioglycolate and α-hydroxyisobutyrate ligands were determined at 20°C. An ionic strength of 0.10 was used in the solutions with sodium perchlorate as the supporting electrolyte. A glass electrode was used for the potentiometric determination of the hydrogen ion concentrations. The acetate constants were found to be in an inverted order from that predicted by ionic radii considerations. The heavier members of the rare-earth series had lower complex formation constants than the lighter members. Similar trends were noted with the methoxyacetate and thioglycolate ligands. The methoxy group and the sulfhydryl group contribute little if any to chelate formation with the rare-earth ions. The values of the first complex formation constant of these ligands with the rare earths are all in the range of 100 to 200 at an ionic strength of 0.10. The α-hydroxyisobutyrate anion formed quite stable complexes with the trivalent rare-earth ions. The formation constants found were greater than the corresponding constants of the glycolate and lactate ligands. The increase in stability is attributed to the inductive effect of the methyl group. The magnitude of the observed constants supported the postulation of a bidentate chelating action of these ligands on the rare earths. The differences in the magnitudes of the individual constants for the various rare earths confirmed previously reported data which showed that α-hydroxyisobutyric acid was an exceptionally good eluting agent for the rare earths in ion exchange systems.

22098 RECOIL TRITIUM REACTIONS WITH ORGANIC MOLECULES IN THE GAS PHASE. Burdon Clair Musgrave (Univ. of Kansas, Lawrence). Dissertation Abstr., 22: 3872(May 1962).

Recoil tritium produced by a nuclear process was shown to substitute for hydrogen in organic compounds in the solid liquid and gas phases. The complexities of the reactions as observed in the condensed phases pointed out the need for

thorough examination of the reactions in the experimentally less complex gas phase. The systems chosen were some simple organic molecules. Experiments were designed to determine effects of molecule structure and reactivity and bond types. The molecules examined were the light hydrocarbons C_1-C_4, CH_2D_2, mixtures of H_2 and D_2, CH_4 and CD_4, dimethyl ether, ethylene oxide, and acetone. It was observed that recoil tritium, formed in these systems by the nuclear reaction $He^3(n,p)T$, reacts with each of these molecules to give HT, labeled parent and labeled fragment molecules which are dependent on the nature of the parent molecule. The fragments from different molecules are similar and can be described as due to simple, usually one step, reactions with the parent where the reactions are the displacement of some group R by the tritium. Few products larger than parent are formed in these systems; all of these are removed by free radical scavengers. Recoil tritium exchange with thermal D atoms does not occur, as with methane and cyclopropane. Exchange can take place into structurally strained cyclopropane and ethylene oxide without isomerization. These two observations demonstrate that the reactions while requiring high kinetic energy to proceed, take place more rapidly than the time necessary for the energy of the tritium to become equilibrated throughout the molecule. The ratio of the formation of HT to DT in mixtures of H_2 and D_2 is favored by a factor of from 1.5 to 1.7 to 1. In CH_2D_2 this ratio is in the range of 1.3 to 1.4 to 1; and in CH_4-CD_4 mixtures the ratio is about 1.25 to 1. The recoil reactions are explained in terms of the structure and reactivity of the molecules. Minor products are explained in terms of the radiation decomposition products and their known thermal reactions. The effects of pressure, added gases, irradiation length and irradiation flux were studied. Pressure influences the rate of stabilization versus decomposition of labeled products, particularly the parent molecule. Added scavengers remove thermal reaction products. It is possible to describe the change in the relative amounts of some of the products with length of irradiation by their appearance or disappearance according to known thermal reactions.

22099 A STUDY OF THE FLUORESCENCE OF ORGANIC SCINTILLANT MATERIALS. Brian Andrew Shortt (Fordham Univ., New York). Dissertation Abstr., 22: 4049-50(May 1962).

An investigation was made to obtain spectroscopic information concerning the photofluorescence spectra of single crystals and liquid solutions of organic materials commonly employed as scintillators. The experimental results were correlated with the theories now in existence which attempt to explain the scintillation process and the phenomenon of transfer of excitation energy. Single crystals of anthracene, naphthalene, and p-terphenyl were prepared with the aid of a crystal-growing furnace constructed during the course of this investigation. In addition, solutions of the above materials in solvents of benzene, cyclohexane, dioxane, hexane, and toluene were also studied. A new liquid scintillator consisting of 4 grams of 2,5-diphenyloxazole and 100 grams of naphthalene per liter of Dow Corning Silicone-555 fluid was likewise investigated. The fluorescence spectra were photographed with a Bausch and Lomb medium-quartz spectrograph on Kodak 103a-O and 103a-F spectroscopic plates. Light from a high pressure, mercury point source was passed through a quartz monochromator and the scintillant material was excited with radiation of approximately 2530 Å and 3650 Å. The optical arrangement of the apparatus was such as to allow the transmission and reflection fluorescence spectra of a sample to be determined. The experimental results for the fluorescence spectra of single crystals of anthracene, naphthalene, and p-terphenyl indicated that reabsorption will alter the short wavelength limit of the spectrum but will not shift the positions of the various band maxima. However, the entire fluorescence spectra of these same molecules suffered a shift in wavelength position when the environment of the fluorescing molecule was changed from a pure crystal to a liquid solution. In addition, the spectra of the various liquid solutions investigated did not demonstrate any dependence on solute concentration, but rather, the wavelength position of the spectra was found to be definitely affected by the solvent employed. By measuring the difference in the short wavelength limit for the reflection and transmission spectra, a measure was made of the amount of overlap between the emission and absorption spectra. The results indicated that anthracene, naphthalene, and p-terphenyl have approximately the same amount of overlap. In addition, no fluorescence which could be attributed directly to naphthalene, was detected for a solution of diphenyloxazole and naphthalene in silicone fluid, although there is known to be an increase in scintillation efficiency with increasing concentration of naphthalene. The spectral shifts observed between the emission of crystals and liquid solutions provided a measure of the interaction energy between solvent and solute molecules, in solutions and between the molecules in a crystal. In this regard, there was shown to be a definite correlation between this interaction energy and the probability of energy transfer and scintillation efficiency, as well as between the decay times of the fluorescent molecules. The experimental results obtained in this investigation strongly favor a theory for the scintillation process which is based more on the interaction energy of the molecules of the scintillant material than on the overlap between the absorption and emission spectra. In general, strong evidence was obtained in favor of the exciton theory of energy exchange in crystals and some radiationless energy transfer process in liquid solutions. The results also indicated that appreciable reabsorption of fluorescence radiation does occur in crystals and it is fairly certain that it is this reabsorption which results in the dependence of observed decay times on crystal thickness. The work showed that certain assumptions made in the postulation of the photon cascade theory do not agree with experimental evidence, and these facts must be taken into account in any future attempts to arrive at a complete theory of energy exchange in the scintillation process.

22100 YTTRIUM HYDRIDE. M. E. Kost (Kurnakov Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 143: 119-21(Mar. 1, 1962). (In Russian)

The hydride was obtained by the direct reaction of yttrium metal and hydrogen. The hydrogen content was determined volumetrically. Pure Y metal does not adsorb hydrogen at room temperature. By heating the metal initially in vacuum at 400°C for 30 minutes, the induction period for the room-temperature hydriding reaction can be lowered to 40 to 60 min. The composition of the pure hydride is $YH_{1.8}$. Yttrium hydride is a blue-gray brittle substance with a density of 4.24 ± 0.15 as compared to a density of 4.91 ± 0.07 for the initial Y metal. The hydride does not change composition on exposure to air for 1 hr, and it reacts slowly with water. Thermographic analysis shows that H_2 is evolved at 360 to 410°C with YH left in the residue. At 1100 to 1300°C the monohydride decomposes to metallic yttrium. Other rare earth hydrides decompose in a single stage at about 1000°C. Other rare earth hy-

drides are a mixture of the metal and dihydride, but $YH_{1.6}$ does not indicate the presence of Y metal by means of x rays. (TTT)

22101 THE FLUORINATION OF URANIUM TETRAFLUORIDE WITH CHLORINE TRIFLUORIDE. N. S. Nikolaev and Yu. D. Shishkov. Doklady Akad. Nauk S.S.S.R., 143: 130-2(Mar. 1, 1962). (In Russian)

UF_4 was fluorinated with ClF_3, and the yield of UF_6 was determined as a function of temperature from 18 to 300°C. The reaction $3UF_4 + 2ClF_3 \rightarrow 3UF_6 + Cl_2$(1) takes place in the condensed state. The reaction rate increases with temperature with a maximum at 50°C with a decrease in yield of UF_6 with a further increase in temperature. The formation of U_4F_{17}, U_2F_9 and UF_4 begins at 100°C according to the following reactions: $12UF_4 + ClF_3 \rightarrow 3U_4F_{17} + \frac{1}{2}Cl_2$(2), $3U_4F_{17} + ClF_3 \rightarrow 6U_2F_9 + \frac{1}{2}Cl_2$(3), and $3U_2F_9 + ClF_3 \rightarrow 6UF_5 + \frac{1}{2}Cl_2$(4). Reactions (2) and (3) predominate up to 100°C. Almost pure UF_5 is found at 150°C. The UF_5 reacts relatively slowly with ClF_3 as follows: $3UF_5 + ClF_3 \rightarrow 3UF_6 + \frac{1}{2}Cl_2$(5). The yield of UF_6 from reaction (5) increases from a minimum at 150°C continuously to 300°C. Comparative experiments show that ClF_3 is a more effective fluorinating agent than fluorine. (TTT)

22102 CATION SIZE EFFECTS IN COMPLEX FLUORIDE COMPOUND FORMATION. R. E. Thoma (Oak Ridge National Lab., Tenn.). Inorg. Chem., 1: 220-6(May 1962).

The influence of cation sizes on the formation and character of complex compounds in binary systems of alkali fluorides with fluorides of metals in groups I to IV is discussed. Cation radius ratio limits are established prescribing binary combinations of these fluorides which can form systems with no intermediate compounds, with few or many intermediate compounds, or with solid solutions. Principal emphasis is given to systems of rare earth and actinide fluorides with the alkali fluorides. Stoichiometry and properties of complex fluoride compounds follow reproducible and systematic patterns which can be correlated with relative sizes of cations involved. From these patterns predictions can be made regarding the characteristic properties of nearly 200 complex fluoride compounds, not yet observed, between the alkali fluorides and the tri- and tetrafluorides of the rare earth and actinide elements. (auth)

22103 COÖRDINATION COMPOUNDS. II. TRENDS IN THE STABILITY OF SOME RARE EARTH CHELATES. M. Cefola, A. S. Tompa, A. V. Celiano, and P. S. Gentile (Fordham Univ., New York). Inorg. Chem., 1: 290-3(May 1962).

A potentiometric study was made of the chelates formed by the cerium group of rare earth chlorides (lanthanum, cerium, praseodymium, and neodymium) with several types of organic compounds, including the amino, hydroxy, and mercapto analogs of acetic, propionic, benzoic, and succinic acids. The order of decreasing stability for the ligands was aspartic, malic, glycine, thiomalic, anthranilic, glycolic, β-alanine, salicylic, β-hydroxy propionic, β-mercapto propionic, and thioglycolic. The stability of chelates with analogs of acetic, propionic, benzoic, and succinic acids decreased for any given acid as the donor group changes from $-NH_2$ to $-OH$ to $-SH$. Considering acids which contain the same donor group ($-NH_2$ or $-OH$ or $-SH$) decreasing stability was observed in the analogs of succinic, acetic, benzoic, and propionic acids, in that order, the only exception being thioglycolic acid which, of all the ligands, formed the weakest chelate. (auth)

22104 ACETATE COMPLEXES OF THE RARE EARTH AND SEVERAL TRANSITION METAL IONS. R. S. Kolat and J. E. Powell (Ames Lab., Ames, Iowa). Inorg. Chem., 1: 293-6(May 1962).

The first two complex-formation constants of acetate anion with trivalent rare earth and divalent copper, zinc, cadmium, and lead ions were determined. The temperature was controlled at 20° and an ionic strength of 0.1 was used. Hydrogen ion concentrations were measured using a glass electrode. (auth)

22105 CERIUM(IV) GLUCONATE COMPLEXES. Donald T. Sawyer and Robert T. Ambrose (Univ. of California, Riverside). Inorg. Chem., 1: 296-303(May 1962).

The cerium(IV) ion forms extremely stable complexes with sodium gluconate in basic solutions. Spectrophotometric, polarimetric, potentiometric, polarographic, and pH measurements were used to study these complexes. At pH 14 and 0.08F sodium gluconate the molar absorptivity for the complex was 4200 at 288 mμ, the absorption maximum. Addition of excess cerium(IV) to a basic gluconate solution initially formed soluble polymers containing approximately six ceric ions per gluconate ion. The polymers hydrolyzed slowly to give ceric hydroxide plus a stable gluconate complex. A number of independent studies were used to establish that the most stable complex contains two cerium(IV) ions per three gluconate ions; at pH 7.3 the formula for this complex is $Ce_2(GH_4)_3(OH)_3^{-4}$ and at pH 11 it is $Ce_2(GH_4)_3(OH)_{11}^{-6}$. Potentiometric measurements plus several assumptions permit a reduction reaction to be proposed for the complex at pH 11; $Ce_2(GH_4)_3(OH)_{11}^{-6} + 2e^- = Ce_2(GH_4)(OH)_4^- + 2GH_4^- + 5OH^-$, where the cerium(IV) complex is reduced to the cerium(III) complex. Tentative formation constants were estimated for both the cerium(IV) and the cerium(III) complexes on the basis of the potentiometric data together with a series of assumptions. (auth)

22106 URANIUM(VI) GLUCONATE COMPLEXES. Donald T. Sawyer and Richard J. Kula (Univ. of California, Riverside). Inorg. Chem., 1: 303-9(May 1962).

The gluconate ion forms stable complexes with uranium(VI), particularly under basic conditions. Spectrophotometric, polarographic, polarimetric, and pH measurements were used to study these complexes. At pH 12 and 0.07F sodium gluconate the complex obeyed Beer's law up to 1.5×10^{-2}F uranium(VI); the molar absorptivity was 129 at 435 mμ, the absorption maximum. The continuous variations method and mole ratio method were used to establish that the most stable complex contains one uranium(VI) per gluconate ion. In the presence of sodium gluconate solutions uranium(VI) gave a well defined polarographic wave at pH 12 with a half-wave potential of -1.26 volts vs S.C.E.; for a supporting electrolyte consisting of 0.1 to 0.5F sodium gluconate and 0.1F NH_4ClO_4 which was adjusted to pH 11, the diffusion current constant (maximum current), I, was 2.27 and the half-wave potential was -1.17 volts vs S.C.E. On the basis of the entire group of studies a formation reaction was proposed for the one-to-one complex: $(UO_2)(OH)^+ + GH_4^- + OH^- = (UO_2)(GH_4)(OH)_2^-$. The average formation constant evaluated for this reaction was 1.8×10^6. (auth)

22107 THE HYDROLYSIS OF LANTHANUM AND CERIUM CARBIDES. Gus J. Palenik and James C. Warf (Univ. of Southern California, Los Angeles). Inorg. Chem., 1: 345-9(May 1962).

The hydrolysis of lanthanum and cerium carbides at various temperatures was investigated. The complex hydrocarbon mixtures resulting from the hydrolysis were analyzed by gas chromatography. The production of acetylene at room temperature was approximately 65 mole %, but no acetylene was produced at 200°. (auth)

22108 BINUCLEAR INTERMEDIATES IN THE REACTION BETWEEN URANIUM(VI) AND CHROMIUM(II). T. W. Newton and F. B. Baker (Los Alamos Scientific Lab., N. Mex.). Inorg. Chem., 1: 368-77(May 1962).

It was found that at least one binuclear intermediate forms rapidly when Cr(II) and U(VI) are mixed in acid solutions near 0°. The spectrum of the intermediate indicated that it is a substituted Cr(III) species. The intermediate reacted with Tl(III) and V(IV) at rates which were first order in the intermediate concentration but zero order in the concentration of oxidizing agent. In the absence of other reactants the intermediate decomposed to give U(IV), U(VI), and Cr(III) with apparent half-times at 0° ranging between 4 and 8 min. Chemical, optical, and kinetic evidence were found for the presence of significant amounts of a second, more reactive, intermediate in the system. (auth)

22109 HYDROLYSIS OF URANIUM(VI): ULTRACENTRIFUGATION AND ACIDITY MEASUREMENTS IN CHLORIDE SOLUTIONS. Richard M. Rush, James S. Johnson, and Kurt A. Kraus (Oak Ridge National Lab., Tenn.). Inorg. Chem., 1: 378-86(May 1962).

Equilibrium ultracentrifugations and emf (acidity) measurements were carried out in chloride solutions for hydroxyl numbers n (average number of hydroxyls bound per uranyl) up to 1.4. Weight average degrees of polymerization between 1 and 2 were found for $n < 0.8$, and from 2 to somewhat less than 3 for higher values of n. A few centrifugations of uranyl perchlorate and nitrate solutions indicated that polymerization is similar in these media. These results indicated that hydrolysis schemes previously proposed which include species no higher than dimers cannot be complete. Further, the intepretation earlier reported of emf (acidity) data by a core-link mechanism, whether a continuous or limited series of polymers is involved, conflicts with present results. An interpretation involving polymers no larger than trimers which are compatible with ultracentrifugation and emf measurements is presented. Comparison of acidity measurements in chloride and perchlorate solutions suggests that there is some difference in the hydrolysis schemes for the two media. Volume and refractive index increments for U(VI) in chloride are presented as a function of n. (auth)

22110 DETERMINATION OF THE RARE EARTH–HEDTA STABILITY CONSTANTS BY THE MERCURY ELECTRODE METHOD. J. E. Powell and J. L. Mackey (Ames Lab., Ames, Iowa). Inorg. Chem., 1: 418-21(May 1962).

The stability constants of the 1:1 complexes formed between the rare earths and the N'-hydroxyethylethylenediamine-N,N,N'-triacetate (HEDTA) anion were determined by the mercury electrode method at a temperature of 20° and an ionic strength of 0.10. The mercury(II)-HEDTA formation constant was measured under the same conditions. (auth)

22111 SUBSTITUTION REACTIONS OF OXALATO COMPLEX IONS. V. KINETICS OF AQUATION OF $Rh(C_2O_4)_3^{3-}$ IN SOLVENT MIXTURES OF H_2O AND D_2O. Kotra V. Krishnamurty (Univ. of Buffalo). Inorg. Chem., 1: 422-5(May 1962).

The kinetics of aquation of the ion $Rh(C_2O_4)_3^{3-}$ were studied in solvent mixtures of H_2O and D_2O using a spectrophotometric method. In ~1M H^+ the half-time for aquation in H_2O at 50° was 47 hr. Other rate data obtained over the range 50 to 80° led to the rate constant expression $k = 8.0 \times 10^{12} \exp(-27{,}000/RT)\ M^{-1}\ sec^{-1}$. The acceleration of rate in solutions containing D_2O enabled evaluation of the solvent deuterium isotope effect, $k_D/k_H = 3.68$. The cubic and the linear forms of the Gross-Butler equation and a medium effect equation were applied in an attempt to interpret the experimental k_n/k_H ratios. (auth)

22112 STRUCTURE OF RARE EARTH PYROSILICATES. A. N. Lazarev, T. F. Tinisheva, I. A. Bondar, and L. N. Koroleva (Inst. of Chemistry of Silicates, Academy of Sciences, USSR). Izvest. Akad. Nauk S.S.S.R., Otdel. Khim. Nauk, No. 4, 557-60(Apr. 1962). (In Russian)

Oscillation spectra of europium pyrosilicate $(R,R')_2Si_2O_7$ (where R and R' are various rare atoms) confirm the postulation on changes in cation coordination state and on the existence of three structural types of rare earth pyrosilicates. (R.V.J.)

22113 RARE EARTH SILICATES. 9. SOLID SOLUTIONS BETWEEN YTTRIUM AND ERBIUM SILICATES. N. A. Toropov, F. Ya. Galakhov, and S. F. Konovalova (Inst. of Chemistry of Silicates, Academy of Sciences, USSR). Izvest. Akad. Nauk S.S.S.R., Otdel. Khim. Nauk, No. 5, 738-43(May 1962). (In Russian)

Investigations are made of $Y_2O_3 \cdot SiO - Er_2O_3 \cdot SiO_2$; $2\,Y_2O_3 \cdot 3\,SiO_2 - 2\,Er_2O_3 \cdot 3\,SiO_2$; and $Y_2O_3 \cdot 2\,SiO_2 - Er_2O_3 \cdot 2\,SiO$ systems. The Y and Er ortho- and diorthosilicates form limited solid solutions, while oxyorthosilicates form a continuous series of solid solution with a minimum at the liquidus point. (R.V.J.)

22114 GROWTH OF REFRACTORY OXIDE SINGLE CRYSTALS. R. C. Linares (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 33: 1747-9(May 1962).

It is found that various refractory oxides can be crystallized from molten $PbO - PbF_2$ and $Bi_2O_3 - BiF_3$ solutions. The $PbO - PbF_2$ solvent proves successful for the growth of high-alumina compounds including aluminum garnets, rare-earth orthoaluminates, spinels, magnetoplumbite-type aluminates, aluminum oxide, and the divalent oxides BeO and MnO. The $Bi_2O_3 - BiF_3$ system proves successful for the growth of the ferrite $GaFeO_3$. The stability ranges of these various compounds are discussed, in addition to problems of doping and attainment of large single crystals. (auth)

22115 SPIN-LATTICE RELAXATION TIME OF RARE-EARTH IONS IN STRONG EXCHANGE FIELDS. R. Orbach (Harvard Univ., Cambridge, Mass.). J. Appl. Phys., 33: 2144(June 1962).

The relaxation time of Yb^{3+} in iron garnet in strong exchange fields is computed using extensions of previous methods for rare-earth ions in magnetic fields in dielectric salts (R. Ohrbach, Proc. Roy. Soc. (London) A264, 458(1961)). For large exchange fields, the crystalline-field and exchange-field matrices must be diagonalized simultaneously. Two-phonon processes begin to contribute to the YbIG relaxation time at liquid-air temperatures; the resonance relaxation process becomes dominant. The high-frequency exchange mode (C. Kittel, Phys. Rev., 115: 1587 (1959)) provides a check of these methods. (L.N.N.)

22116 INFRARED SPECTRA OF CRYSTALLINE C_2H_4 AND C_2D_4. David A. Dows (Univ. of Southern California, Los Angeles). J. Chem. Phys., 36: 2833-5(June 1, 1962).

High-resolution infrared spectra of crystalline ethylene and fully deuterated ethylene were obtained. Accurate frequencies of all band components observed at 65°K are presented. Appearance of one gas-phase inactive fundamental in the crystal spectrum, and the structures of certain multiplets, showed that the presently accepted crystal structure is not correct. This conclusion is in agreement with that from a previous study under lower resolution. (auth)

22117 ANGULAR DEPENDENCE OF THE FIRST-ORDER TRANSITION DENSITY AND SPIN DENSITY FOR MANY-ELECTRON ATOMS. Werner A. Bingel (Max-Planck-Institut für Physik and Astrophysik, Munich). J. Chem. Phys., 36: 2842-6(June 1, 1962).

The spinless first-order transition density between two atomic states with quantum numbers $L',M_{L'}$, and $L'',M_{L''}$ was expanded in spherical harmonics $\gamma_{m,s}(r) = \Sigma_{L=|L'-L''|}^{L'+L''} \langle L,M_{L'} - M_{L''}(\theta,\phi) \cdot r^L \gamma L,M_{L'} - M_{L''}\rangle^2 (r)$. It is shown that the dependence of the expansion coefficients on $M_{L'}$ and $M_{L''}$ for fixed L is completely determined by the use of the Wigner-Eckart theorem, so that all $(2L' + 1)(2L'' + 1)$ expansion coefficients of a given order L are known in terms of one of them. The same is true for the expansion coefficients of the first-order transition spin density. These quantities were calculated for all terms of the electron configurations $s^n p^m$ and the results collected in tables. (auth)

22118 VIBRATIONAL SPECTRA OF MoF_6 AND TcF_6. Howard H. Claassen, Henry Selig, and John G. Malm (Argonne National Lab., Ill.). J. Chem. Phys., 36: 2888-90 (June 1, 1962).

Infrared spectra of gaseous MoF_6 and TcF_6 from 6 to 43 μ, the Raman spectrum of MoF_6 gas, and an incomplete Raman spectrum of liquid TcF_6 are reported. These are interpreted in terms of the octahedral point group O_h. The fundamental frequencies for MoF_6 are 741(ν_1), 643(ν_2), 741(ν_3), 265(ν_4), 306(ν_5), and 190(ν_6). For TcF_6 they are 705(ν_1), 551(ν_2), 748(ν_3), 265(ν_4), and 255(ν_5), and ν_6 was not determined. Differences between the spectra of MoF_6 and TcF_6 are explained as a consequence of orbital degeneracy in the ground state of the latter, in analogy with similar differences in the 5d series. (auth)

22119 VIBRATIONAL SPECTRA OF ReF_6. Howard H. Claassen, John G. Malm, and Henry Selig (Argonne National Lab., Ill.). J. Chem. Phys., 36: 2890-2(June 1, 1962).

The infrared-absorption spectrum from 6 to 43 μ and the Raman spectrum of ReF_6 gas are reported. They are interpreted in terms of the octahedral point group O_h. The six fundamental frequencies are 755(ν_1), 596(ν_2), 715(ν_3), 257(ν_4), 246(ν_5), and 193(ν_6). Thermodynamic functions were calculated for the ideal gaseous state. (auth)

22120 STUDIES OF THE SHAPES OF IONIZATION-EFFICIENCY CURVES OF MULTIPLY CHARGED MONATOMIC IONS. I. INSTRUMENTATION AND RELATIVE ELECTRONIC-TRANSITION PROBABILITIES FOR KRYPTON AND XENON IONS. Robert W. Kiser (Kansas State Univ., Manhattan). J. Chem. Phys., 36: 2964-8(June 1, 1962).

The determination of threshold ionization potentials for multiple ionization processes in krypton and xenon is shown to depend upon the threshold law assumed for these processes. Support was obtained for the kth power rule for k-fold ionization by electron impact. Ionization potentials were obtained for multiple ionization in these gases. It was found that the output electron current of the magnetic electron multiplier, obtained for the multiply charged positive ions, depends strongly upon the charge of the ion impinging upon the ion cathode of the multiplier. (auth)

22121 OPEN-SHELL CALCULATIONS OF HYPERFINE SPLITTING FOR THE GROUND STATE OF Li-LIKE IONS. J. Kerwin and E. A. Burke (St. John's Univ., Jamaica, N. Y.). J. Chem. Phys., 36: 2987-8(June 1, 1962).

The hyperfine splitting of the ground state of lithium was calculated using analytic open-shell wave functions. The difference in the experimental and calculated value for the Li^7 nucleus by this method is 36.468 Mc/sec as compared to a difference of 57.011 Mc/sec using Hartree-Fock wave functions. The nuclear-spin-independent contribution to the hyperfine splitting was computed for the Li-like ions He^- to Ne^{7+} using both open- and closed-shell wave functions, and the results are discussed with reference to contributions from the orbital and core electrons. (auth)

22122 METALLIC COHESION AND VIBRATION SPECTRUM OF COPPER. B. Dayal and B. B. Tripathi (Banaras Hindu Univ., Varansi, India). J. Chem. Phys., 36: 3002-5 (June 1, 1962).

A method of setting up a secular determinant for copper is described in which the ion–ion force constants are not based on hypothetical force models but were derived from known expressions appearing in the theory of metallic cohesion. Numerical calculations were made for copper. The Coulomb coupling coefficient was taken from Kellermann's work on sodium chloride, while the contribution of the ion–ion exchange was calculated from Fuchs' force constants. The single elastic constant due to the remaining terms of the interaction was calculated, and was used to find an expression for the electronic coupling coefficient on the lines of Bhatia's work. There was good agreement between the calculated frequencies for the longitudinal 110 branch and the experimental ones observed in neutron scattering. The calculated θ-T curve was found to be about 6 to 7% higher than the experimental curve. This is due to the fact that the repulsive force constant of Fuchs is definitely an overestimate and gives higher value of C_{44}. If this constant is calculated from observed value of $(C_{11} - C_{12})$ and C_{44}, the calculated curve will almost coincide with the experimental one without spoiling the agreement with the results of neutron scattering. (auth)

22123 MODELS FOR ISOTOPE RATE EFFECTS IN DISPLACEMENT, DISSOCIATION, ELIMINATION, AND ADDITION REACTIONS. Sidney I. Miller (Illinois Inst. of Tech., Chicago). J. Phys. Chem., 66: 978-83(June 1962).

Detailed calculations of isotope rate factors, k/k', for representative reactions, e.g., dissociation, displacement, elimination, and addition are presented. Various approximations for three-center, reactant-like, product-like, and complete models of the activated complex were tested. At 27°, some results are as follows: for methyl iodide in SN1 reaction, $k_{12}/k_{13} = 1.05$, $k_H/k_D = 1.53$; for methyl iodide with iodide ion in SN2 reaction, $k_{12}/k_{13} = 1.17$, $k_H/k_D = 0.70$; for sym-tetrachloroethane with iodide in dechlorination (E2), $k_H/k_D \simeq 1.6$; for chlorine addition to 1,2-dichloroethene, $k_H/k_D \simeq 0.8$. The linear three-center model for an SN2-activated complex was unsatisfactory for cases in which one of the masses was polyatomic. (auth)

22124 EFFECTS OF SOLUTION COMPOSITION ON THE POTENTIALS OF THE COUPLES: Np(V-VI), Fe(II-III), Hg(0-I), AND Hg(I-II). A. J. Zielen and J. C. Sullivan (Argonne National Lab., Ill.). J. Phys. Chem., 66: 1065-9 (June 1962).

A linear variation with hydrogen ion concentration was found for the formal potential of the Np(V-VI) couple at 25° in perchloric acid-sodium or lithium perchlorate solutions of ionic strength 2. The major portion and very probably all of this acid dependence is shown to be caused by activity coefficient changes, reaffirming NpO_2^+ and NpO_2^{++} as the only Np(V) and Np(VI) species of consequence in acid solutions. Similar measurements in sodium perchlorate solutions were made of the Fe(II-III), Hg(0-I), and Hg(I-II) couples. Equations for the formal potentials as a function of hydrogen ion concentration are given, and activity coefficient effects produced by the substitution of Na^+ or Li^+ for H^+ at constant ionic strength are discussed. (auth)

22125 SIGNIFICANT STRUCTURE THEORY OF LIQUID HYDROGEN IN ITS VARIOUS ORTHO-PARA AND ISOTOPIC FORMS. Douglas Henderson, Henry Eyring, and Dale Felix (Univ. of Utah, Salt Lake City). J. Phys. Chem., 66: 1128-32(June 1962).

The significant structure theory of liquids was extended to include liquid hydrogen in its various ortho-para and isotopic forms. It was assumed that liquid hydrogen has a quasi-lattice structure in which the "lattice sites" are occupied either by hydrogen molecules or holes of molecular size. Such a hole will confer gas-like properties on a molecule which jumps into it and also will give rise to a degeneracy in the solid-like structure. On this basis a partition function can be written down for liquid hydrogen. The thermodynamic properties of para-hydrogen, normal hydrogen, hydrogen deuteride, ortho-deuterium, and normal deuterium were calculated for temperatures ranging from the triple point to temperatures considerably above the boiling point. Critical constants also were calculated. The results were in good agreement with experimental data. In addition, the surface tensions of normal hydrogen, hydrogen deuteride, and normal deuterium were calculated with good results. (auth)

22126 SPECTRA OF DILUTE SOLUTIONS OF BISMUTH METAL IN MOLTEN BISMUTH TRIHALIDES. I. EVIDENCE FOR TWO SOLUTE SPECIES IN THE SYSTEM BISMUTH–BISMUTH TRICHLORIDE. Charles R. Boston and G. Pedro Smith (Oak Ridge National Lab., Tenn.). J. Phys. Chem., 66: 1178-81(June 1962).

Solute bismuth metal in chloride-rich melts of the system $Bi-BiCl_3$ was found to be partitioned into two chemical species which obey the law of additive absorbances. Absorption spectra from 450 to 750 mμ are reported for molten $Bi-BiCl_3$ mixtures 0.0027 to 0.7 M in solute bismuth metal at path lengths as short as 24 μ and at temperatures of 264, 350, and 433°. The spectrum consists of an intense, broad band with a maximum near 560 mμ. Large apparent deviations from Beer's law were found at all wave lengths. These spectra had the characteristics expected for solutions with two light-absorbing solute species. Phenomenological equations were derived which describe the spectra of solutions consisting of any given number of solute species derived from a common substance. (auth)

22127 KINETIC DEUTERIUM ISOTOPE EFFECT IN THE NITROSATION OF ANILINE. THE DEUTERIUM ISOTOPE EFFECT ON THREE EQUILIBRIUM CONSTANTS. John O. Edwards, Khairat M. Ibne-Rasa, Etsuyo Itokawa Choi, and Colin C. Rice (Brown Univ., Providence). J. Phys. Chem., 66: 1212-13(June 1962).

An attempt to use the solvent deuterium isotope effect to sort out the correct mechanism for aniline nitrosation was unsuccessful. Equilibrium constants for hydration of acetaldehyde were determined in H_2O and D_2O. Data indicated there was an isotope effect on the equilibrium constant. (M.C.G.)

22128 THE IONIZATION POTENTIAL OF HYDROGEN DISULFIDE (H_2S_2). Robert W. Kiser and Brice G. Hobrock (Kansas State Univ., Manhattan). J. Phys. Chem., 66: 1214 (June 1962).

In the course of a study of the mass spectrum and the appearance potentials of different ions from 3,4-dithiahexane, it was found that the m/e = 66 ion is quite intense. The abundances of m/e = 68 and m/e = 70, due to the natural abundance of S^{34}, indicated that m/e = 66 contains two sulfur atoms and is nearly entirely due to $H_2S_2^+$ at 70 ev. The appearance potential of the $H_2S_2^+$ ion was found to be 12.2 ± 0.2 ev. Ionization and dissociation processes were studied, and ΔHp^+ (H_2S_2) was calculated to be 239 kcal/mole. It was concluded that D (HS–SH) = 59 ± 3 kcal/mole. (M.C.G.)

22129 FRANCK-CONDON FACTORS TO HIGH VIBRATIONAL QUANTUM NUMBERS II: SiO, MgO, SrO, AlO, VO, NO. R. W. Nicholls (Univ. of Western Ontario, London). J. Research Natl. Bur. Standards, 66A: 227-31(May–June 1962).

Franck-Condon factor arrays were computed numerically to high vibrational quantum numbers for the band systems of the following: SiO: $(A^1\Pi - X^1\Sigma^+)$; MgO: $(B^1\Sigma - A^1\Pi)$; MgO: $(B^1\Sigma - X^1\Sigma)$; SrO: $(A^1\Sigma - X^1\Sigma)$; AlO: $(A^2\Sigma^+ - X^2\Sigma^+)$; VO: $(A^2\Delta - X^2\Delta)$; NOβ: $(B^2\Pi - X^2\Pi)$, and NOγ: $(A^2\Sigma^+ - X^2\Pi)$. (auth)

22130 ELECTRON TRANSFER SPECTRA OF LANTHANIDE COMPLEXES. Chr. Klixbuell Joergensen (Cyanamid European Research Inst., Cologne). Mol. Phys., 5: 271-7(May 1962).

Moderately strong, very broad absorption bands observed in dilute lanthanide bromide solutions in nearly anhydrous ethanol were interpreted as electron transfer from the highest filled M.O. to the partly filled 4*f* shell in the case of Nd(III), Sm(III), Eu(III), Tm(III), and Yb(III). Good agreement was obtained with a theory taking its parameters from the internal 4*f* transitions. Electron transfer bands were also observed for Eu(III) and Yb(III) dialkyldithiocarbamates, and the narrow bands of similar Pr(III), Nd(III), Sm(III), and Eu(III) complexes are briefly discussed. Relatively narrow $4f \rightarrow 5d$ transitions were observed in the Ce(III), Pr(III), and Tb(III) bromide solutions and related to the same theory. As expected, no bands were observed for Gd(III), Dy(III), Ho(III), Er(III), and Lu(III). (auth)

22131 SCALING OF THE PLATT ELECTROSTATIC MODEL OF DIATOMIC HYDRIDES. G. G. Hall and D. Rees (Imperial Coll., London). Mol. Phys., 5: 279-84(May 1962).

The Platt electrostatic model of a diatomic hydride was modified by the introduction of a scale factor which depends on the internuclear distance. This has the theoretical advantage of enabling the molecular virial theorem to be satisfied and the practical advantage, as shown by some examples, of improving the agreement with experiment particularly for the lighter molecules. The calculation of the scale factor requires two more integrals but the equilibrium internuclear distance and the force constant can still be interpreted electrostatically. (auth)

22132 THE DIFFERENCE BETWEEN THE SECOND VIRIAL COEFFICIENTS OF ISOTOPIC METHANES AT LOW TEMPERATURES. G. Thomaes and R. van Steenwinkel (Free Univ. of Brussels). Mol. Phys., 5: 307-11(May 1962).

The second virial coefficient of normal methane, $C^{12}H_4$, was compared with that of the corresponding deutero compound $C^{12}D_4$, as well as with the other isotopic molecule, $C^{13}H_4$. These measurements were performed by means of a differential apparatus over a range of temperature extending from 110°K up to 300°K. (auth)

22133 USE OF THE FREQUENCIES OF ISOTOPIC MOLECULES FOR THE DETERMINATION OF THE FORCE CONSTANTS OF NONLINEAR SYMMETRIC MOLECULES OF THE TYPE XY_2. R. R. Shvangiradze and Sh. Z. Dzhamagidze. Optics and Spectroscopy (U.S.S.R.) (English Translation), 12: 200-2(Mar. 1962).

The most reliable values for the zero-order frequencies of H_2S, NO_2, SO_2, and some of their isotopic substitution products were used for the calculation of a complete set of force constants and interaction coefficients. Accuracy of the results is discussed. The force constants obtained

were used for determination of the zero-order and fundamental frequencies of isotopic species of these molecules. (auth)

22134 THE ELECTRON PARAMAGNETIC RESONANCE SPECTRA OF POLYSTYRENE RADICALS. I. S. Milevskaya and M. V. Vol'kenshtein. Optics and Spectroscopy (U.S.S.R.) (English Translation), 12: 209-11(Mar. 1962).

Quantum-mechanical calculations were performed for the spin density distribution in radicals created by the mechanical destruction and irradiation of polystyrene. Results, which agree with the observed magnitudes of the hyperfine splitting in the electron paramagnetic resonance spectra, show that various types of radicals are created, depending on the conditions during treatment. The conformation of one of these radicals was determined. (auth)

22135 AN OPTICAL METHOD FOR FILTERING THE GREEN LINE OF Hg^{198}. N. R. Batarchukova, A. I. Kartashev, and A. P. Kirichenko. Optics and Spectroscopy (U.S.S.R.) (English Translation), 12: 232-3(Mar. 1962).

Methods for narrowing the spectral lines of Hg^{198} using resonance absorption are discussed. Arrangements for a "Zeeman absorption filter" for the narrowing of resonance lines and for a "heat absorption filter" are described. Using the latter, it was possible to reduce the width of the Hg λ 0.5461 μ line emitted by an electrodeless Megger's type lamp cooled to 15°C by a factor of approximately 1.5-2. An interference pattern of fringes of equal inclination was obtained with a path difference of 750 mm in a Fabry-Perot etalon. (auth)

22136 PROPERTIES OF LITHIUM HYDRIDE. IV. F-CENTER FORMATION AT LOW TEMPERATURES. F. E. Pretzel, G. V. Gritton, C. C. Rushing, R. J. Friauf, W. B. Lewis, and P. Waldstein (Los Alamos Scientific Lab., N. Mex.). Phys. and Chem. Solids, 23: 325-37(Apr. 1962). (In English)

The growth of the F-band in LiH crystals is studied in samples exposed to x rays, thermal neutrons, and β particles at low temperatures. The F-band growth curves obtained for LiH are compared to growth curves for alkali halides irradiated under similar conditions. Probable mechanisms for the production of F-centers and H_2 molecules in V-type centers in LiH are discussed. Several LiH crystals containing LiT at various concentrations are prepared so that comparable samples cleaved from these crystals can be used for concurrent measurements of the effect of a regularly rising F-center concentration on a number of crystal properties. In this way the growths of the F-band, the F-center paramagnetic resonance, and the crystal volume are correlated to the steady production of F-centers and interstitial He^3 atoms by tritium decay in the crystals. The optical absorption of the interstitial He^3 atom in LiH is observed at 3.4 ev, and the β band is found at 4.7 ev. Increasing F-center concentration and thermal annealing reduce the relaxation time of the F-center paramagnetic resonance in LiH. The aggregation of F-centers is associated with quite drastic changes in the paramagnetic resonance band. (auth)

22137 BORN MODEL TREATMENT OF THE POLYMORPHIC TRANSITIONS OF THE ALKALI HALIDES. M. P. Tosi and F. G. Fumi (Argonne National Lab., Ill.). Phys. and Chem. Solids, 23: 359-66(Apr. 1962). (In English)

The Born model of ionic solids is shown to account for the observed values of the work involved in the pressure transition of the potassium and rubidium halides from the NaCl to the CsCl structure, and for the heat absorbed in the thermal transition of cesium chloride from the CsCl to the NaCl structure, when the repulsive parameters are allowed to depend on the crystal structure. A repulsive energy form with two parameters is used in the calculation, and these parameters are determined separately for the NaCl phase and for the CsCl phase of each compound, from the observed values of the lattice parameter and of the compressibility of the two phases at the transition point. The motivation and physical significance of this procedure are discussed. (auth)

22138 A NOTE ON NEGATIVE THERMAL EXPANSION COEFFICIENTS. M. J. Klein and R. D. Mountain (Case Inst. of Tech., Cleveland). Phys. and Chem. Solids, 23: 425-7(Apr. 1962). (In English)

A typical frequency spectrum $g(\nu)$ is shown for a crystal, consisting of a parabolic region that can be described by $g(\nu) = \alpha\nu^2$ at low ν, a region at higher ν having maxima and minima, and a high-ν cutoff. It is suggested that for temperatures (T) so low that only vibrations in the parabolic region are excited, an increase in pressure (P) at constant T could cause an increase in the number of vibrational modes available to the crystal (i.e., an increase in α). This increase in α with pressure, however, corresponds to a positive value of $\partial S/\partial P$ (constant T). Since the thermal expansion coefficient β is given by $\beta = -V^{-1}(\partial S/\partial P)$ (constant T), the suggestions brought forward could represent a mechanism whereby β could be negative at low T. (T.F.H.)

22139 PARAMAGNETIC RESONANCE OF Tb^{3+} IONS IN $CaWO_4$ AND CaF_2. P. A. Forrester and C. F. Hempstead (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 126: 923-30(May 1, 1962).

The paramagnetic resonance absorption spectra of Tb^{3+} ions in single crystals of $CaWO_4$ and CaF_2 were studied at 4.2°K at 4 to 50 kMc/sec. The observed spectra fit a simple spin Hamiltonian $\mathcal{H} = g_{||}\beta H\cos\theta S_z + \Delta_x S_x + \Delta_y S_y + AS_z I_z$. Because the zero-field splittings in these crystals fall in the microwave region, direct measurement of the parameters in the Hamiltonian was possible and these agreed with those obtained from the high-frequency measurements. In $CaWO_4$, the parameters are $g_{||} = 17.777 \pm 0.005$, $\Delta = (\Delta_x^2 + \Delta_y^2)^{1/2} = 8.131 \pm 0.006$ kMc/sec and $A = 6.284 \pm 0.005$ kMc/sec. In CaF_2, there are two sets of spectra, one having axial symmetry about the cubic axes, and the other having axial symmetry about the body diagonals of the cube. The spectra having symmetry about the cubic axes are interpreted as resulting from Tb^{3+} ions which have a charge-compensating F^- ion occupying the nearest neighbor interstitial site. The spectra having symmetry about the body diagonals can arise from Tb^{3+} ions which have either a charge-compensating F^- ion occupying the next-nearest interstitial site or a charge-compensating O^{2-} ion occupying the site of one of the eight F^- ions surrounding the paramagnetic ion. The parameters in the spin Hamiltonian are, respectively: $g_{||} = 17.77 \pm 0.02$, $\Delta = 5.134 \pm 0.006$ kMc/sec, and $A = 6.26 \pm 0.01$ kMc/sec; $g_{||} = 17.28 \pm 0.01$, $\Delta = 31.67 \pm 0.02$ kMc/sec, and $A = 6.10 \pm 0.01$ kMc/sec. (auth)

22140 NUCLEAR MAGNETIC RESONANCE OF Tc^{99} IN Tc METAL AND Tc^{99} AND V^{51} IN Tc–V ALLOYS. D. O. Van Ostenburg, H. Trapp, and D. J. Lam (Argonne National Lab., Ill.). Phys. Rev., 126: 938-40(May 1, 1962). (ANL-FGF-299)

The nuclear magnetic resonance of Tc^{99} was observed in Tc and its Knight shift measured relative to a solution of $CsTcO_4$. The Tc^{99} and V^{51} resonances were studied in 50–50 at.% TcV and TcV_3 alloys as a function of field and temperature. The Tc^{99} resonance curves in TcV and TcV_3 have a Lorentzian shape, while V^{51} is Gaussian in

TiV and Lorentzian in TcV_3. Probable causes for the shape changes and excess widths encountered are discussed. (auth)

22141 ANHARMONIC SPECIFIC HEAT OF SOLIDS. A. J. E. Foreman (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Proc. Phys. Soc. (London), 79: 1124-41(June 1, 1962).

The high-temperature correction to the lattice specific heat arising from the anharmonic terms in the crystal potential energy is estimated on the basis of the elastic continuum approximation. The anharmonic constants are estimated from the measured thermal expansion and dependence of the elastic constants on temperature and pressure. In evaluating the temperature dependence of the elastic constants, the Born approximation $\omega^2 \rightarrow \omega^2$ is not made, since it neglects the effect of strain on the phonon frequencies arising from the perturbation of the polarization vectors. Results are compared with those of the anharmonic oscillator and linear chain models and with a lattice model having nearest-neighbor interatomic forces. The anharmonic specific heat correction (at constant pressure) of a metal such as iron is about 15 to 20% at 1000°K, but this result is sensitive to the measured values of the temperature coefficient of the elastic constants. The continuum model predicts the correct order of magnitude of the effect for germanium. (auth)

22142 FORMATION OF DOUBLE HYDROXIDES AND THE TITRATION OF CLAYS. R. C. Turner and J. E. Brydon (Soil Research Inst., Canada Dept. of Agriculture, Ottawa). Science, 136: 1052-4(June 22, 1962).

The buffering region above pH 7.0 and below the pH at which $Mg(OH)_2$ precipitation is expected, revealed in the titration curve for MgO added to Al^{3+}-saturated Wyoming bentonite in a dilute salt solution, is discussed. It is indicated that double hydroxides are formed in the clay suspensions, causing the buffering region. (L.N.N.)

22143 DEPENDENCE OF THE INTENSITY OF LUMINESCENCE OF SILVER HALOGENIDES ON THE INTENSITY OF EXCITATION. S. I. Golub and N. A. Orlovskaya (Mechnikov State Univ., Odessa). Ukrain. Fiz. Zhur., 6: 758-61(1961). (In Russian)

A study of intensely increasing luminescence (flashes) in AgCl single crystals showed that they occur mainly during a time interval of about 1 minute but the subsequent course depends on the intensity of excitation; during weak excitation saturation is quickly attained, while with intense excitation a slow increase in the brightness of the luminescence lasts 5 to 10 minutes longer. In the case of a break in excitation during 1 minute, the previous level of luminescence is attained immediately after resumption of excitation. This indicated that the centers of capture remain filled for a long time after the cessation of excitation. An investigation of the dependence of the intensity of excitation showed that it is of a linear nature in the region of the temperatures in which there is no temperature extinction. (auth)

22144 ABSORPTION SPECTRA AND PHOTOLUMINESCENCE OF HgI_2 CRYSTALS. I. S. Gorban and S. N. Rudko (Shevchenko State Univ., Kiev). Ukrain. Fiz. Zhur., 6: 764-7(1961). (In Russian)

Results are presented of measurements of the absorption spectrum and energy distribution in the luminescence spectrum of mercury iodide. The data on the intensity and structure of the absorption spectrum indicated that the inherent absorption in crystals is due to transitions between states of various parity. The discrete structure of the absorption spectrum is connected with excitation of exciton states. In the photoluminescence spectrum luminescence due to transitions from exciton levels and luminescence of local centers of the crystal lattice defect type were observed. On the basis of data on the ratio of the intensities in photoluminescence bands, an analysis was carried out on the conditions of the transformation of exciton excitation energy into inherent radiation, into radiation of impurity centers, and into non-radiation transitions. Questions of the kinetics of exciton excitations are discussed. (auth)

22145 A SPECTROSCOPIC STUDY OF THE EXCITATION FUNCTIONS OF ATOMS AND MOLECULES. I. P. Zapesochnyi, S. M. Kishko, V. S. Shevera, P. V. Feltsan, and L. L. Shimon. Ukrain. Fiz. Zhur., 6: 770-4(1961). (In Russian)

The method of electronic collisions was used to investigate the excitation functions of the spectral lines of atoms of Na (λ = 5890, 5896 Å), Ne (λ = 5852 Å) and Cd (λ = 5086 Å) and of molecular objects; bands of the second positive system N_2 (λ = 4089 Å), the comet system CO^+ (λ = 4566 Å) and the system NO^+ (λ = 4380 Å). Excitation was effected by slow electrons with energies in the interval 10 to 150 ev with heterogeneity 0.6 to 1.5 ev. Radiation was recorded by an electrophotometer, using a photoelectronic multiplier. The results of some measurements are shown. It was assumed that the cause of the appearance of fine structure on optical excitation function curves is cascade transitions for atoms and the effect of the processes of dissociation, ionization, and their reverse processes (recombination) for molecular objects. (auth)

22146 GROWING OF LANTHANUM ETHYL SULFATE SINGLE CRYSTALS WITH GADOLINIUM AND CERIUM ETHYL SULFATE IMPURITIES AND THEIR PHYSICAL PROPERTIES. S. A. Peskovatskii, A. N. Chernets, G. I. Postogvard, T. G. Sheina, and I. N. Oleinik (Khar'kov Inst. of Radiophysics and Electronics). Ukrain. Fiz. Zhur., 7: 22-30(Jan. 1962). (In Ukrainian)

Ethyl sulfates of the rare earths (chemical formula $M^{+++}(C_2H_5SO_4)_3 \cdot 9H_2O$, where M^{+++} was an ion of lanthanum, gadolinium, or cerium) were prepared by mixing equivalent quantities of sulfate of the rare earth and barium ethyl sulfate in solution. The growing of single crystals was effected by the method of gradual cooling of a saturated solution. The duration of crystal growth was 10 to 12 days, the temperature of the solvent decreased during this time by 7 to 9°C, and the crystals were 15 to 20 mm in length and had a transverse dimension of 10 to 15 mm. The crystals obtained were stable in vacuum and air on cooling from room temperature to that of liquid helium and heating back to room temperature, if the ethyl sulfates were subjected to recrystallization before mixing. The dielectric permeability ϵ' and the tangent of the angle of loss tan δ of the single crystals were measured at a frequency of 9 kMc within a temperature range of 290 to 4.2°K. The measurements showed that ϵ' decreased from 3.4 at 290°K to 2.7 at 4.2°K. The measurement error did not exceed 3 per cent, tan δ depended greatly on the temperature and decreased from 8×10^{-2} at 290°K to 1.5 or 2×10^{-3} at 4.2°K. The precision of the tan δ determination at the high temperatures was of the order of 5%, and at liquid helium temperature was of the order of 50 per cent. (auth)

22147 ON CERTAIN PROPERTIES OF THE EXCITON ABSORPTION SPECTRUM OF A SODIUM URANYL ACETATE SINGLE CRYSTAL. M. S. Brodin and Ya. O. Dovgii (Inst. of Physics, Academy of Sciences, Ukrainian SSR, Kiev). Ukrain. Fiz. Zhur., 7: 31-6(Jan. 1962). (In Ukrainian)

Absorption spectra of a sodium uranyl acetate single

crystal were obtained in circular-polarized light at temperatures of 20 and 4°K. At 20°K nine narrow stripes were obtained, characterized by great circular dichroism. Most of the stripes divided into two or three components at 4°K. In the case of one of these stripes, at 21135 cm^{-1}, it was shown that its intensity and form depended on the thickness of the crystals. (auth)

22148 SELF-DIFFUSION MEASUREMENTS IN MOLTEN SALTS. A MODIFIED DIFFUSION COUPLE TECHNIQUE. Lars-Erik Wallin (Univ. of Goteborg). Z. Naturforsch., 17a: 191-5(Mar. 1962). (In English)

A new technique was developed for the determination of self-diffusion coefficients in molten salts. Two chemically identical columns of salt, one of which is radioactive, are allowed to diffuse into each other in a capillary. The diffusion is interrupted by means of freezing from the bottom. Equations are derived for the calculation of the disturbed concentration distribution, assuming that the contraction on freezing causes a Poiseuille flow in the melt above. (auth)

22149 ZINC ION SELF-DIFFUSION IN MOLTEN ZINC BROMIDE. A REDETERMINATION. Lars-Erik Wallin (Univ. of Goteborg). Z. Naturforsch., 17a: 195-8(Mar. 1962). (In English)

The diffusion coefficient of zinc in molten zinc bromide was re-measured with a new technique over the temperature interval 400 to 565°C. The result is a downward shift of the values as compared to previous data. Assuming a relation of the form $D = D_0 \cdot e^{-Q/RT}$, the values of the constants are: $D_0 = 0.405$ cm^2/sec and $Q = 19{,}000$ cal/mole. (auth)

22150 CHARGE MEASUREMENTS FOR Li IONS ON FREE-CARRYING FOILS. K. Bethge and H. Fabricius (Universität, Heidelberg). Z. Physik, 168: 143-7(1962). (In German)

Measurements of the equilibrium charge distribution of lithium ions in the energy range 3 to 10 kev passing through very thin foils are described. For the components $F_{0\infty}$ and $F_{1\infty}$ a mean value of 0.5 was found. (auth)

22151 GALVANOSTATIC AND POTENTIOSTATIC INVESTIGATION ON ACTIVE AND PASSIVE URANIUM IN AQUEOUS ELECTROLYTES AND THE STRUCTURE ANALYSIS OF THE OXIDE SURFACE LAYER. Roland W. Ohse and Ernst Raub (Kernforschungszentrum, Karlsruhe, Ger. and Forschungsinstitut fur Edelmetalle und Metallchemie, Gmund, Ger.). Z. physik. Chem. (Frankfurt), 31: 87-110(Jan. 1962). (In German)

The electrochemical behavior of active and passive U, especially the synthesis and conversion of oxide surface layers, was investigated in aqueous solutions by galvanostatic and potentiostatic methods. By structure analysis of the oxide surface layers with x-ray and electron defraction patterns and by comparison of the steady-state reference voltage measured oscillographically with the equilibrium reference voltages calculated from thermodynamic data, the formation of UO_2, U_3O_8, UO_3, and $UO_3 \cdot 2H_2O$, in addition to the hydrogen and oxygen evolution, were determined by the electro-reactions $UO_2 + H_2O \rightarrow UO_3 + 2H^+ + 2e$, $U_3O_8 + H_2O \rightarrow 3UO_3 + 2H^+ + 2e$, and $UO_2 + 3H_2O \rightarrow UO_3 \cdot 2H_2O + 2H^+ + 2e$. Simultaneous, completely currentless, irreversible transformations of UO_3 into $UO_3 \cdot 2H_2O$ and of U_3O_8 into UO_2 and $UO_3 \cdot 2H_2O$ could be observed. A long anodic charge at constant current leads to a decline of the O_2 evolution because of the growth of the poorly conducting UO_3 layer and into a sharp increase of the reference voltage up to the layer breakdown. (tr-auth)

22152 THE URANIUM–HYDROGEN SYSTEM AND THE KINETICS OF URANIUM HYDRIDE FORMATION. E. Wicke and Kl. Otto (Universität, Münster, Ger.). Z. physik. Chem. (Frankfurt), 31: 222-48(Feb. 1962). (In German)

The unstable α modification of uranium hydride was prepared in a pure form. The lattice constant of the α deuteride (4.150 Å) is shown to be, as in the β modification, about 0.01 Å smaller than that of the α hydride. The hysteresis phenomena in the formation and decomposition of the uranium hydride can be traced back to the mechanical stresses that occur in formation with sharp volume increase. The formation pressure is accordingly too high; the decomposition pressure corresponds to the equilibrium of the system $U/\beta-UH_3$ with the state of the uranium arising directly as in decomposition. The decomposition enthalpy and entropy of the β modification between 200 and 400°C were found to be $\Delta H(UH_3) = 30.5 \pm 0.7$ and $\Delta H(UD_3) = 30.9 \pm 0.7$ kcal/mole and $\Delta S^0(UH_3) = 43.3 \pm 0.35$ and $\Delta S^0(UD_3) = 44.7 \pm 0.35$ cal/mole. The higher decomposition pressure of UD_3 with respect to UH_3 (approximately 1.5 times) can be traced back to the excessive effect of the higher entropy of the D_2 molecule with respect to the H_2 molecule in the gas phase. The velocity of the hydride formation in compact uranium with hydrogen at pressures from 1 to 760 Torr between −80 and 100°C can be quantitatively described by $dn_{H_2}/dt = \underline{a} \times \underline{b} \times \sqrt{p}/(\underline{b} + \underline{a}\sqrt{p})$ cm^3 NTP/cm^3 sec. The frequency factors of the $\underline{e}$ functions a(P) and b(T) are shown, in measurements with D_2, to be smaller by $\sqrt{2}$. The hydride formation proceeds via the hydrogen atom. The supplementary concentration of H atoms at the metal surface occurs in the sense of a hydrogen transfer catalysis over the surface of the hydride. (tr-auth)

22153 PHYSICO-CHEMICAL STUDY OF THE COMPLEX FORMATION OF BERYLLIUM IONS WITH ORGANIC LIGANDS. PART IV. WITH MALONIC ACID AND ITS DERIVATIVES. Arun K. Bhattacharya and G. S. Rao (Univ. of Saugor, India). Z. Physik. Chem. (Leipzig), 219: 11-16 (1962). (In English)

Beryllium sulfate was found to form 1:1 complexes with malonic acid, sodium malonate, and diethyl malonate. The complex formation was studied by the electrical conductance data, potentiometric data, and spectrophotometric data in the ultraviolet region with the help of Job's continuous variation method. The values of the dissociation constants thus obtained are 9.55×10^{-4} for malonic acid, 9.24×10^{-4} for sodium malonate, and 9.81×10^{-4} for diethyl malonate at 28°C. A precise structure was attributed to the complex formed and justified both from theoretical considerations and from practical data. As can be seen from a comparison of the values of the dissociation constants, the complex with sodium malonate is slightly more stable than the complex formed with malonic acid and the complex formed with the ethyl substituted malonic acid is slightly less stable than that formed with malonic acid, presumably due to the weakening of the electron donating properties of the acid. (auth)

22154 SOME EFFECTS OF HYDROGEN ON THE CORROSION MECHANISM OF METALS. J. S. L. Leach and A. Y. Nehru (Imperial Coll. of Science and Tech. and Royal School of Mines, London). IAEA Preprint CN-13/7. 18p. (In English)

To be published in the Proceedings of the IAEA Conference on the Corrosion of Reactor Materials held in Salzburg, 4-9 June 1962.

Theories, to account for the well documented effects of hydrogen on the corrosion of uranium, zirconium, and other

oxide-covered metals, have primarily been concerned with possible effects on the mechanical properties of the oxide-metal system. The results of recent studies of the corrosion kinetics of uranium showed that cathodic polarization can result in greatly increased corrosion rates during both the protective (time-dependent) region and the non-protective (time-independent) region of corrosion. This suggests a different possible mechanism for the effect of hydrogen, involving its solution in the oxide. Studies of the electrochemical-electrode properties of oxide-covered metals showed that the presence of hydrogen may, in some circumstances, greatly increase the electronic conductivity of the surface oxide without changing its thickness. This increase in conductivity can, in turn, permit an increase in the ionic diffusion rate in the oxide after the model for silver sulfide developed by Wagner. (auth)

22155 LIQUID METAL CORROSION MECHANISMS. J. R. Weeks, C. J. Klamut, and D. H. Gurinsky (U. S. Atomic Energy Commission, Washington, D. C.). IAEA Preprint CN-13/11. 53p. (In English)

To be published in the Proceedings of the IAEA Conference on the Corrosion of Reactor Materials held in Salzburg, 4-9 June 1962.

The corrosion of solid metals by liquid metal coolants and fuels is a complex process. Kinetics of dissolution and precipitation of solid metals in liquid metals, and complex multi-component solubilities and their temperature coefficients are both part of the corrosion mechanism. In addition, non-metallic impurities (O, N, C) affect both the kinetics and the solubilities. An atom of a solid metal dissolves in a liquid metal by breaking its bonds with its neighbor like-atoms and forming new ones with liquid atoms. This process is dependent on the structure at the solid-liquid interface. The dissolved atom then migrates perhaps with its "solvation sheath," through the relatively quiet liquid adjacent to the solid metal into the main body of coolant. This migration is a function of the liquid flow. The exchange of electrons that occurs during dissolution of the solid metal is not well understood; it is likely to influence both the dissolution and diffusion processes, as indicated by electro-diffusion experiments. The magnitude and temperature coefficients of the solubilities of solid metals in liquid metals cannot be predicted by the present theories of liquid alloys. They appear to depend upon the band structure of the liquid alloy, and upon the relative atomic diameters of the solute and solvent atoms in the liquid alloy. Magnetic susceptibility, electrical resistivity, and alloy density measurements are useful guides in advancing the theory. Precise experimental liquidus measurements of very dilute alloy systems are at present the most reliable means of interpreting the corrosion mechanisms in a given system. O, N, and C in many cases catalyze corrosion by liquid metals. They both accelerate the dissolution rate and increase the solubility of many solid metals in alkali liquid metals, presumably by forming soluble complexes. Zr and Ti additions to the liquid metals inhibit corrosion of steels by Pb, Bi, and Hg by reacting with C and/or N in the steel to form surface deposits of carbides and/or nitrides which are a barrier to dissolution. Examples are cited from the literature that illustrate the kinetic and thermodynamic processes occurring during liquid metal corrosion. (auth)

22156 CORROSION MECHANISM OF ZIRCONIUM, COLUMBIUM, AND THEIR ALLOYS. I. DIFFUSION OF OXYGEN IN ZIRCONIUM DIOXIDE AND COLUMBIUM PENTOXIDE. D. L. Douglass (General Electric Co., Pleasanton, Calif.). IAEA Preprint CN-13/18. 41p. (In English)

To be published in the Proceedings of the IAEA Conference on the Corrosion of Reactor Materials held in Salzburg, 4-9 June 1962.

The diffusion rate of oxygen through ZrO_2 and Nb_2O_5 was determined by the interface migration of stoichiometric oxide in anion-deficient oxide. Measurements were made on fully densified oxide bodies formed by hot pressing. Independent checks were made using manometric and O^{18} exchange methods. Diffusion of oxygen in a defect lattice of columbium oxide of the composition, $Nb_2O_{4.878}$, is given by $D = 0.0358 \exp(-28{,}200/RT)$. Preliminary data show that small amounts of foreign cations (less than 1 mole percent, added as oxides), which would correspond to compositions of alloy corrosion films, were effective in reducing the diffusion rate of oxygen in columbium oxide. Data are presented for zirconium, titanium, vanadium, and chromium additions. Corrosion and oxidation behavior are analyzed in terms of cation additions and their effect on both the oxide defect structure and the oxygen gradient across the film. The latter, which is determined by the diffusion of oxygen in the metal substrate, can be shown to be rate-controlling in some cases for columbium alloys. A one-order-of-magnitude difference was measured for oxygen diffusion through columbium oxide containing either titanium or zirconium cations when diffusion anneals were performed in steam instead of purified oxygen. A model is present to explain the effect of hydrogen on oxygen diffusion. Grain boundary diffusion in zirconium dioxide is much more rapid than lattice diffusion which is highly anisotropic. Penetration of the stoichiometric oxide fingers occurred initially, and eventually complete grain boundary envelopes were formed. The effect of grain size on diffusion is discussed. Diffusion through columbium oxide occurred uniformly and did not appear to be anisotropic or depend heavily on grain boundaries. The small amounts of alloying additions which significantly alter the corrosion rates can not change the Pilling-Bedworth ratio sufficiently to account for the improved corrosion resistance. The physiochemical aspects of the corrosion films appeared to be most important, although mechanical properties of both oxide and metal contribute to corrosion behavior. In some cases, oxygen-saturated alpha zirconium formed in the zirconium oxide grain boundaries during hot pressing and subsequently caused shattering of the oxide by preferential oxidation during diffusion anneals. These items are discussed with respect to corrosion transition phenomena in zirconium alloys. (auth)

22157 THE EFFECT OF TEMPERATURE ON THE MANNER OF OXIDATION OF LARGE BLOCKS OF GRAPHITE IN AIR. J. B. Lewis, R. Murdoch, and P. Hawtin (Atomic Energy Research Establishment, Harwell, Berks, Eng.). IAEA Preprint CN-13/33. 20p. (In English)

To be published in the Proceedings of the IAEA Conference on the Corrosion of Reactor Materials held in Salzburg, 4-9 June 1962.

Experiments with large tubular blocks of unirradiated nuclear graphite oxidizing in air show that at temperatures above about 500°C the oxidation is confined to zones adjacent to the exposed surfaces. The depths of these zones, which diminish with temperature, were compared with those predicted from various diffusional theories. It was found that the diminution in the activation energy resulting from this diffusional effect is complicated by other factors such as the differing effect of catalysts at the higher temperatures. (auth)

22158 ANODIZATION PHENOMENA ON ALUMINIUM AND ALUMINIUM ALLOYS. M. J. Brabers (Centre d'Études de l'Énergie Nucléaire, Mol, Berg.). IAEA Preprint CN-13/37. 25p. (In English)

To be published in the Proceedings of the IAEA Conference on the Corrosion of Reactor Materials held in Salzburg, 4-9 June 1962.

The formation of oxide layers on high purity aluminium and its alloys was investigated by means of the "transitometer." This apparatus comprises a constant current source and a switch which opens the circuit at certain preset tensions of the electric current and of an electronic timer working simultaneously. In this way, the time is measured in which a tension is built up at the surface of the electrode. The measured E versus t (tension-time) curves show sudden time peaks, which indicate that during the anodization process the oxide layer is broken up at certain places of the surface and new oxide is formed. The breaks show up at "irregularities" such as grain boundaries and scratches. The effect of the surface preparation on the anodization process is very pronounced. These results are confirmed by a salt-spray test. The highest corrosion resistance is found after a polishing treatment with alumina 0.1 μ or with emery paper 240. Aluminium alloys behave in an analogous way as high purity aluminium. The effect of heat treatments on the corrosion of aluminium slightly alloyed with Mg, Fe, Ni, Cr, and Mn is shown. (auth)

22159 THE NATURE OF OXYGEN IN LIQUID SODIUM. B. A. Nevzorov. IAEA Preprint CN/13/40. 14p. (In Russian)

To be published in the Proceedings of the IAEA Conference on the Corrosion of Reactor Materials held in Salzburg, 4-9 June 1962.

Experiments were conducted to investigate the nature of oxygen dissolved in liquid sodium at temperatures of 300 and 600°C. A series of experiments consisting of passing a direct current through liquid sodium revealed transport of oxygen to the anode and a relative constancy in the amount of oxygen transported per amp/hr of current passed. It was found that at 300°C the amount of oxygen transported is approximately 0.07 mg per amp/hr, and that at 600°C this amount increases to 0.475 mg. Calculations are made indicating that transport occurs through polarization of negative oxygen ions present in the liquid sodium by the direct current field. Some remarks are made on the mechanism of dissociation of sodium oxide molecules in a liquid sodium at high temperatures and on the mechanism of corrosion of structural materials and of carbon transport in liquid sodium due to the presence of negative oxygen ions. (auth)

22160 THE MECHANISM OF CARBON TRANSFER IN LIQUID SODIUM. V. S. Lyashenko and B. A. Nevzorov. IAEA Preprint CN-13/41. 36p. (In Russian)

To be published in the Proceedings of the IAEA Conference on the Corrosion of Reactor Materials held in Salzburg, 4-9 June 1962.

Experiments were carried out to investigate transfer of carbon from cast iron, carbon steel, low-alloy perlite steel, and chrome steel to austenitic steel and high-nickel alloys in liquid sodium with varying oxygen content at temperatures up to 650°C. The relationship between decarbonization and carbonization of steels and their chemical composition and content of carbide-forming elements and carbides is shown. Certain kinetic relationships between carbon transfer and the sodium oxygen-content, the temperature and the duration of the process were investigated. Experiments are described showing details of the various processes observed in transfer of carbon in liquid and gaseous sodium, and also determining the part played by ionic oxygen in the formation of carbon monoxide, the carbon carrier. The probable mechanism of carbon transfer in liquid sodium is discussed, their mechanism consisting of two stages. The first stage covers formation of carbon monoxide molecules on the surface of certain materials as the result of reaction between carbon and oxygen ions and also involves diffusion of carbon monoxide through the volume of the reaction. (auth)

22161 DRY CORROSION OF NON-ALLOYED ZIRCONIUM. J. Debuigne and P. Lehr (Centre d'Études de Chimie Métallurgique, Vitry/Seine, France). IAEA Preprint CN-13/45. 39p. (In French)

To be published in the Proceedings of the IAEA Conference on the Corrosion of Reactor Materials held in Salzburg, 4-9 June 1962.

It is shown that the corrosion of non-alloyed zirconium by carbon dioxide at atmospheric pressure is fundamentally an oxidation process: the kinetics of zirconium corrosion by CO_2 or O_2 are actually very similar and the increases in mass are comparable. The corrosion films formed at the surface of the metal are in both cases composed essentially of monoclinic zirconia. To understand the phenomena of zirconium corrosion by carbon dioxide it is therefore necessary to have an exact knowledge of the behavior of this metal during oxidation. The kinetics of oxidation of zirconium in a dry oxygen atmosphere was studied at temperatures between 600° and 850°C. A micrographic and radiocrystallographic analysis of the oxide layers formed at the surface of the metal was carried out. It is shown that the phenomenon of formation and growth of a surface oxide film is accompanied by considerable diffusion of the oxygen in the underlying metal: the increase in mass of the test specimens submitted to the oxidation tests is largely due to this diffusion of oxygen in the metal, a phenomenon which also results in making the metal more brittle. In interpreting the kinetics of zirconium oxidation at the temperatures considered, the competition between the following two basic phenomena must be taken into account: (1) The diffusion of oxygen through the oxide layer formed. (2) The diffusion of oxygen in the underlying metal. On the basis of experimental determination of the increases in mass of the test specimens and measurements of the thickness of the oxide layers, the coefficients of oxygen diffusion in the oxide and in the metal were determined and the corresponding activation energies calculated. (auth)

Radiation Chemistry and Radiochemistry

22162 (NP-11529) APPEARANCE AND IONIZATION POTENTIALS OF SELECTED FRAGMENTS FROM ISOTOPICALLY LABELED PENTABORANES. Joyce J. Kaufman, Sally S. Wright (RIAS. Div. of Martin Co., Baltimore); W. S. Koski (Johns Hopkins Univ., Baltimore); and L. J. Kuhns (Callery Chemical Co., Penna.). Apr. 5, 1962. Contract Nonr 3471(00). 45p.

Appearance potentials of isotopically labeled pentaboranes, $B_5^{11}H_9$ and $B_5^{11}D_9$, and some of their fragment ions as determined by mass spectrometric electron impact measurements are presented. A set of apparently self-consistent ionization potentials for the pentaboranes and various fragments were calculated from these appearance potentials using what little thermochemical bond energy data are available combined with the interpretation of the processes

taking place on ionization and fragmentation. $A(B_5H_9) > A(B_5D_9)$ is compared to $A(B_2H_6) < A(B_2D_6)$ and possible reasons for the reversal of ionization potential differences are discussed. Using an IBM 7090 computer program, monoisotopic fragmentation patterns for normal and deuterated pentaborane were calculated from the mass spectra of these compounds at 70 ev. (auth)

22163 (PAN-288/ChR) DETERMINATION OF RADIATION YIELD OF HYDROGEN BY GAS CHROMATOGRAPHY METHOD. Zbigniew Kęcki and Henryk Wincel (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Dec. 1961. 10p.

A gas chromatographic method for the direct determination of hydrogen G values from radiolytic gas products is described. The method can be applied to other gases including those dissolved in a liquid phase. (auth)

22164 (PAN-296/XVII) THE RADIATION INDUCED OXIDATION AND REDUCTION REACTIONS OF IRON IN AQUEOUS SOLUTIONS. I. COMPLEX COMPOUNDS OF Fe(III) IN PERCHLORIC AND SULPHURIC ACIDS. Roman Broszkiewicz and Stefan Minc (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Jan. 1962. 22p.

The absorption spectra of ferric ion solutions in perchloric and sulfuric acids were investigated. The solution were 10^{-4} M and 10^{-3} M in Fe^{3+} and 10^{-3} to 1.0 N in acids. The contribution of particular ferric complexes were calculated for 10^{-3} and 10^{-1} N acid solutions. The association constant for ferric and sulfate ions was determined as equal to (114 ± 9) 1/m at $21.5 \pm 2°C$. (auth)

22165 (TID-16048) THE REARRANGEMENT OF ALLOXAN AND ITS DERIVATIVES (thesis). Richard W. Spayd (Oak Ridge National Lab., Tenn.). June 1962. Contract [W-7405-eng-26]. 83p.

Submitted to Univ. of Delaware, Newark.

C^{14} was used to follow the course of the rearrangement of alloxan, together with its derivatives, from a 6-membered to a 5-membered ring. Alloxan-5-C^{14} was rearranged to alloxanic acid under several different conditions of pH. Chromic acid oxidation of the alloxanic acid so produced yielded parabanic acid which contained all of the radioactivity associated with the starting alloxan. Thus, a nitrogen-carbon bond rather than a carbon-carbon bond was obviously broken, in disagreement with previous theory concerning the mechanism of the rearrangement. Confirmation of these results was obtained upon rearrangement of alloxan-4-C^{14}, for the resultant parabanic acid contained one-half the radioactivity of its precursors. Substitution of the various R groups on the nitrogens did not alter the result. In several unsymmetrically substituted alloxans, it was possible to determine the relative migratory aptitudes of the nitrogen-carbon bonds contained in the alloxan molecules. (auth)

22166 (AEC-tr-5094) NEUTRON IRRADIATION OF ARSENIC TRICHLORIDE–BENZENE SYSTEMS. I. Tsifka. Translated from p.185-93 of "Chemical Effects of Nuclear Transformations. Proceedings of a Symposium, Prague, October 24-27, 1960. Vol. I" (a publication of the International Atomic Energy Agency, 1961). (STI/PUB/34(Vol. I)(p.185-93)). 12p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 16, abstract no. 6477.

22167 (FTD-TT-62-296) THE POLYMERIZATION OF NITROETHYLENE BY γ-RAYS. V. N. Sokolov, I. Ya. Poddubnyi (Poddubnyy), V. V. Perekalin, and V. F. Evdokimov (Yavdokimov). Translated from Doklady Akad. Nauk S.S.S.R., 138: 619-20(May 21, 1961). 5p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 15, abstract no. 26079.

22168 (SCL-T-422) INVESTIGATION OF SURFACE PROCESSES WITH RADIOACTIVITY. H. Frauenfelder. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.) from Helv. Phys. Acta, 23: 347-80(1950). 42p.

A survey of boundary surface processes on solids is presented. New methods for measuring desorption probabilities, sticking coefficients, and surface diffusion coefficients by means of radioactive substances are described. Recoil atoms from K capture are recorded. This allows the measurement of the adsorption of thin gas layers at low pressures and with extremely small diffusion coefficients. Experimental results are given and compared to investigations carried out by other methods. Applications to nuclear physics are: the rapid separation of radioactive elements and the preparation of very thin sources. (auth)

22169 ESR STUDY OF THE RADIATION CHEMICAL PROCESS IN POLYETHYLENE. Shun-ichi Ohnishi (Osaka Labs.). Bull. Chem. Soc. Japan, 35: 254-9(Feb. 1962). (In English)

Polyethylene was irradiated in vacuo at −196°C with a variety of doses, and the change in the obtained electron spin resonance spectrum with the rising temperature was followed. The results are discussed from the standpoint of the mechanism of radiochemical changes in irradiated polyethylene. A free-radical-formation curve was obtained. (M.C.G.)

22170 EFFECTS OF OUTER ANIONS ON THE RECOIL REACTIONS IN THE IRRADIATED HEXAMMINECOBALT-(III) COMPLEX COMPOUNDS. Nobufusa Saito, Takeshi Tominaga, and Hirotoshi Sano (Tokyo Univ.). Bull. Chem. Soc. Japan, 35: 365-6(Feb. 1962). (In English)

The distribution of recoil species in various hexamminecobalt(III) complex salts containing different kinds of outer anions was investigated in order to elucidate the role of the outer anions in recoil reactions. Nine complexes were irradiated. The distribution of Co^{60}-labeled recoil species was found to vary with the kind of outer anion in the target. It was indicated that the facility of incorporation of outer anions into ligands around the hot cobalt atom might mainly depend on the stability of such anions as ligands in cobalt-(III) complexes. (M.C.G.)

22171 THE PRODUCTION OF PARAMAGNETIC CENTERS IN IRRADIATED SUGARS. Germaine Lomaglio (Faculté des Sciences, Besancon, France). Compt. rend., 254: 2534-6(Apr. 2, 1962). (In French)

The production and disappearance of paramagnetic centers in irradiated sugars were studied by electron paramagnetic resonance. A very marked effect of air was shown. (tr-auth)

22172 RADIOCHEMICAL SYNTHESIS OF PRE-CALCIFEROL$_2$ BY COBALT-60 γ RAYS. Pierre Arnaud and Francis Balestic. Compt. rend., 18: 3198-9(Apr. 30, 1962). (In French)

The irradiation under vacuum of ergosterol in the solid state by Co^{60} γ rays leads to the formation of precalciferol$_2$ at a temperature of 20°C. The radiochemical yield is equal to 8 for a delivered dose of 46×10^{18} ev/g at at intensity of 5.8×10^{18} ev/gh. (tr-auth)

22173 HOT ATOM CHEMISTRY OF PHOSPHORUS IN ITS OXY-ANIONS. Vincent Charles Anselmo (Univ. of Kansas, Lawrence). Dissertation Abstr., 22: 2561(Feb. 1962).

The chemical reactions of P^{32} atoms formed by the

$P^{31}(n,\gamma)$ nuclear reaction were investigated in crystalline phosphorus compounds. The observed distributions of radioactivity among phosphorus compounds were then fitted into a comprehensive pattern for these energetic reactions. Neutron irradiations for 15 to 30 minutes at approximately 10^{12} neutrons/cm^2/sec created the P^{32} atoms within the phosphorus compounds. Separation of the irradiated substances into various products was accomplished by paper electrophoresis, and analysis for radioactivity carried out by end-window, gas-flow proportional counting. The usual experimental conditions (1" × 60" Whatmann 3MM paper, 0.1 M lactic acid, 16 volts/cm) separated known compounds in order of increasing rate of migration: isohypophosphate < orthophosphate < orthophosphite < hypophosphite ≅ pyrophosphate ≅ hypophosphate. Irradiated orthophosphates showed at least five major P^{32}-radioactive compounds, identified on the basis of migration rates and chemical treatment of irradiated species. In order of increasing migration rate, they are: complex unknown pentavalent phosphorus anion, isohypophosphate, orthophosphate, orthophosphite and hypophosphite. Pyrophosphate and hypophosphate were shown to be negligible on the basis of selective chemical treatments. Tripolyphosphate was not detected. Irradiated ammonium orthophosphates showed no hypophosphites and a reduction in orthophosphite. These chemical changes are attributed to recombination reactions causing oxidations of these species. More recombination occurs in ammonium salt because of the greater radiation damage from the $N^{14}(n,p)C^{14}$ reaction. The P^{32} compounds found in irradiated hypophosphate include a complex P(V) anion, orthophosphate, orthophosphite, hypophosphite and the parent compound. Irradiated pyrophosphate contains the same set of products (with the proper parent compound), and isohypophosphate as well. Irradiated orthophosphite and hypophosphite contained orthophosphate, orthophosphite, and hypophosphite. A non-migratory radioactivity peak, identified as elemental P^{32}, was also found in hypophosphite. An oxidized species, probably orthophosphate, was discovered in neutron irradiated red phosphorus. The proposed mechanism postulates that the P^{32} atom is unable to recoil very far in the large majority of the spectrum of gamma recoils. The parent activity is then formed by retention of the P^{32} in the original configuration. Reduced states are formed by the loss of oxygen atoms from the recoil configuration. Isohypophosphate anions are formed by the recombination reaction of (PO_2) fragments with PO_4^{3-}. Similar reactions of (PO_3) fragments are not observed, since the PO_3^{3-} can become stabilized in the orthophosphate lattice. Simple recombination reactions cannot be written leading to tripolyphosphate in orthophosphate, or isohypophosphate in irradiated hypophosphate, in agreement with the failure to observe these species. The slow-moving complex-anion is believed to be formed in a hot-zone generated when a very energetic phosphorus atom recoils from its configuration and loses its energy in multiple collisions in this zone. Recombination of these fragments results in this complex oxy-anion. It is significant that this species is observed only in the pentavalent phosphorus compounds (ortho-, pyro-, hypophosphate), but not in irradiated phosphorus of lower oxidation states, for which complex anions are unknown.

22174 POLAR EFFECTS IN THE RADIATION CHEMISTRY OF p-SUBSTITUTED POLYSTYRENES. Vinicio Serment-Cabrero (Univ. of Michigan, Ann Arbor). Dissertation Abstr., 22: 2745-6(Feb. 1962).

Polar effects in the radiation chemistry of polystyrenes were studied. Specifically, the electronic environment about the backbone carbon atoms of polystyrene was altered by introducing electronegative or electropositive substituents (-H, $-OCH_3$, $-CH_3$, -Cl, -Br, -CN, and $-NO_2$) in the para-position of the benzene ring. The para-substituted polymers were γ-irradiated in vacuo (Cobalt-60) at a dose rate of 2.3×10^5 R/Hr, at a total dose of 4.5×10^6 R, temperatures ranged from -200 to 25°C. The susceptibility to γ-induced bond breakage of the C-H bonds in the polymers was determined from mass spectrometric examination of the decomposition gases, viscometrical molecular weight determinations, and doses for incipient gelation. From these data, G-values for hydrogen formation and G-values for crosslinking were calculated. When γ-irradiated, the only significant gas resulting from decomposition of the polymer backbone was H_2. It was found that all p-substituted polymers liberate less H_2 than polystyrene. Furthermore, all the para-substituted polystyrenes either crosslinked when irradiated, or, within experimental error, exhibited no change in molecular weight. Except for the p-halopolymers, all these polymers crosslinked to a lesser extent than polystyrene. These results, together with data reported by others on radical reactions in solutions and in the gas phase suggest that free radical species formed early in the reaction are responsible for the major radiation effects observed, i.e., hydrogen formation and crosslinking, and that these effects can be explained in terms of the resonance stability of the intermediate radicals formed as a result of the γ-irradiation. Thus, a substituent in the para-position of such an intermediate will delocalize the free electron on the α-carbon atom (making it unavailable for reaction) by resonance interaction through the benzene ring involving ortho- and para-quinoid structures. The inordinality high sensitivity to crosslinking noted for the para-halopolymers, suggest that a chain reaction involving the radiation susceptible C-halogen bond is an important factor in the radiation chemistry of these materials.

22175 PART A: THE $2\nu_3$ BAND OF METHANE. PART B: EQUILIBRIUM BOND LENGTHS IN HYDROGEN CYANIDE. Daniel Robert Peden Eastman (Pennsylvania State Univ., University Park). Dissertation Abstr., 22: 2837(Feb. 1962).

Two long focal length spectrometers incorporating the latest available high quality diffraction gratings, linear scanning devices and PbS detectors were employed to examine the following problems. The rotational lines for $J \leq 10$ of the P, Q, and R branches of the $2\nu_3$ band of methane were measured against six standard neon lines in the visible by using wavelength interpolation techniques. The fine structure components were measured with high relative precision by employing a Fabry Perot interferometer. Specially prepared three layer dielectric films on the etalon plates gave a resolving power of 400,000. By making use of theoretical line contours it was possible to detect fine structure and measure the splittings of lines whose separation was less than the Doppler half width of the lines. This complex fine structure is the maximum that can be observed in lines with Doppler half width of 0.0189 cm^{-1}. The equilibrium bond lengths of HCN were determined to an accuracy of several parts in 10^5 and the effect of isotopic substitution on equilibrium bond lengths was investigated. The 101-000 and 11^11-01^10 bands of $DC^{12}N^{14}$ and the 002-000, 01^12-01^10 and 101-000 bands of $HC^{13}N^{14}$ were measured to an accuracy of ±0.002 cm^{-1}. From an analysis of these bands of $HC^{13}N^{14}$ and $DC^{13}N^{14}$ and from available data on $HC^{12}N^{14}$, $B_{101}-B_{000}$ and $B_{010}-B_{000}$ were evaluated for each isotope. The microwave values of B_{000} were employed to yield the equilibrium rotational constants B_e for each

isotope. From these values of B_e and the atomic masses the equilibrium bond lengths were determined. The measurements give for the most probable value of d_{CN} 1.15313 ± 0.00002 A and d_{CH} 1.06593 ± 0.00010 A. Within the accuracy of the measurements no change in the equilibrium bond lengths could be found for different isotopic species.

22176 ELECTRON SPIN RESONANCE IN IRRADIATED POTASSIUM AZIDE AND FUSED SILICA. Alexander Joseph Shuskus (Univ. of Connecticut, Storrs). Dissertation Abstr., 22: 2848-9(Feb. 1962).

Single crystals of potassium azide irradiated at room temperature by ultraviolet or Co^{60} gamma rays revealed a nine line hyperfine pattern when measurements were performed at 77°K. The relative intensities of the nine lines appeared consistent with the ratios that are predicted for an electron interacting with four equivalent nuclei of spin one, namely, 1:4:10:16:19:16:10:4:1. The model proposed to explain the ESR spectra is a linear N_4^- molecule-ion which lies in the 110 plane. The defect is thought to be located on a line joining two adjacent azide ion vacancies with its molecular axis directed in either the 110 or $1\bar{1}0$ direction, each site being equally populated. The spin Hamiltonian was derived and fitted to the observed spectra. Reasonable agreement between theory and experiment was obtained. Fitting of the data resulted in a choice of 7% 2s-character and 93% 2p-character for the unpaired electrons in order to account for the observed hyperfine splitting. The measured values of the g tensor were $g_x = 2.005 \pm 0.001$, $g_y = 1.997 \pm 0.001$, and $g_z = 2.002 \pm 0.001$. The hyperfine interaction was found to be $A_x = A_y = 2.9 \pm 0.2$ gauss and $A_z = 9.4 \pm 0.2$ gauss. Corning 7943 fused silica exposed to the unfiltered radiation of an Hanovia SH low-pressure mercury lamp developed a weak optical absorption band at 212 mμ and a narrow asymmetric resonance with g = 2.0006 ± 0.0006. Samples heated to their softening point in an oxygen–acetylene flame and quenched in water showed the resonance weakly before irradiation. Significant enhancement resulted in the spin resonance of uv-irradiated samples from quenching prior to irradiation. It was determined that the threshold energy required for the development of the spin resonance lay between 4.1 and 4.8 electron volts. Quenching also produced an optical absorption at 247 mμ. The band was completely removed by an anneal at 700°C. This band was attributed to silicon in a reduced state. Other fused silicas behave similarly except for Corning 7940 which gives neither paramagnetic nor optical absorption when subjected to the above treatment. A 10^6-r Co^{60} gamma irradiation of 7943 produced two ESR lines of equal intensity with g = 2.0018 ± 0.0006 and a separation of 75 gauss. Each line had a width of approximately 4 gauss at inflection points. While the data of the gamma-induced doublet was being interpreted, it was found that Weeks and Nelson had also detected the doublet in irradiated Corning silica. They found a qualitative correlation between water content (determined by infrared) and the intensity of the spin resonance and suggested proton hyperfine interaction. It was proved by deuterium exchange that the doublet results from proton hyperfine interaction. The nature of this paramagnetic defect remains undetermined.

22177 INVESTIGATIONS OF RADIATION EFFECTS IN α-Al_2O_3 BY ELECTRON SPIN RESONANCE. Charles Gilbert Young (Univ. of Connecticut, Storrs). Dissertation Abstr., 22: 2849(Feb. 1962).

Electron spin resonances were observed in uv-, gamma-, 1.8-Mev electron- and reactor-irradiated α-Al_2O_3. These resonances were observed at about 9.2 kMc/sec and at a variety of irradiation and observation temperatures. Spectra from at least five different paramagnetic centers were observed. Gamma-ray irradiation produced a single asymmetric resonance absorption. The isotropic g value for this absorption was 2.010 ± 0.005 at 77 and 300°K and 2.050 ± 0.003 at 4.2°K. The line width was 40 gauss at 77°K and above, 18 gauss at 4.2°K. The growth behavior of this absorption was similar to that of optical absorptions in aluminum oxide. The growth saturated at about 10^5 r, which indicated that the absorption arises from the ionization of initially present imperfections in the crystal. Ultraviolet irradiation produced a similar absorption, but with only one-tenth the intensity and with indication of a partial resolution of the absorption into 2 lines. More than one paramagnetic center may cause the gamma- and uv-induced resonances. The electron spin resonance measurements suggested that reactor irradiation produces both oxygen and aluminum displacements, while 1.8-Mev electron irradiation produces primarily the latter. Two centers were tentatively identified: O^+ and O^-. The center believed to be O^+ had an effective spin ½ and a zero-field splitting of D = +1.12 ± 0.04 kMc/sec. This spectrum appeared only after 77°K gamma irradiating a previously reactor-irradiated sample. It annealed rapidly at 160°K and could be bleached at 77°K by room-light. The g values for this spectrum were $g_\perp = 2.025 \pm 0.003$ and $g_\parallel = 2.019 \pm 0.003$. The position of the spectral lines followed closely a $(3\cos^2\theta - 1)$ dependence. The center believed to be O^- had an effective spin of ½ and an isotropic g value of 2.008 ± 0.003 at 77°K and above. The line width varied from 22 to 32 gauss, depending on reactor dose. In both reactor and 1.8-Mev electron-irradiated aluminum oxide a twelve-line spectrum centered on g ≈ 2.0 was observed which may arise from hyperfine interaction with aluminum nuclei. The spectra for the two types of irradiation were similar except that the maximum splitting of the reactor-induced spectrum is 1600 gauss, while that for the 1.8-Mev electron-induced spectrum was 2200 gauss. The x-band superheterodyne spectrometer used for these investigations is described in detail. In addition, the conditions imposed on the microwave cavity by the necessity for low temperature irradiations are discussed and the cavity design which evolved therefrom is described.

22178 RADIOLYSIS OF ALKYL HALIDE-HYDROCARBON SOLUTIONS AND SZILARD-CHALMERS CHEMISTRY OF ALKYL HALIDE-HYDROCARBON SOLUTIONS. Paul Robert Geissler (Univ. of Wisconsin, Madison). Dissertation Abstr., 22: 3867(May 1962).

Work was carried out to obtain a better understanding of the interactions occurring between solvent and solute during irradiations of alkyl halide-hydrocarbon solutions. This was done by investigating the chemical fate of several alkyl halide solutes which were labeled with either I^{131} or C^{14} and whose concentration in pentane solutions was varied. Using optical spectrometry and gas chromatography, the products of the gamma radiolysis were identified and their yields determined. In dilute solutions of methyl iodide in pentane, the observed products, included methane, ethane, propane, n-butane, n-hexane, 2- and 3-methylpentane, and ethyl, n-propyl, n-amyl iodides, and 2- and 3-iodopentane. The G values of the hydrocarbon products increased with increasing methyl iodide concentration from 0 to 0.75 mole %, and were constant from 0.75 to 2.3%, the highest concentration studied. The G values for iodinated products formed in the radiolysis of pentane solutions were equal for CH_3I and C_2H_5I solutes at concentrations of 1.2%, and appeared to be constant from 1 to 10% when ethyl iodide was the solute. The amount of methane produced in methyl iodide-pentane solutions was about fifteen times the yield of the remaining

hydrocarbon products. Its yield was decreased by 95% by the addition of molecular iodine. Using iodine tagged with I^{131} as a radical scavenger, it was found that the addition of an alkyl iodide or bromide at about one mole per cent to iodine-pentane solutions greatly increased the yield of the corresponding alkyl radical, while the yield of the remaining radicals decreased by approximately 30%. The addition of n-propyl chloride to an iodine-pentane solution did not significantly change the yield of any of the radicals formed by ionizing radiation. Iodine was produced in the radiolysis of ethyl iodide–pentane solutions at concentrations above about 5% ethyl iodide. With increasing concentration, $G(I_2)$ increased linearly with the fraction of the total energy absorbed by ethyl iodide. G(HI) in a solution of 2.0% ethyl iodide in pentane was less than 0.04. These observations are consistent with the conclusion that dissociative electron capture by the alkyl halide is an important process in the radiolysis of alkyl halide–hydrocarbon solutions, the electrons being formed from the hydrocarbon by ionizing radiation. The radicals formed by this dissociation can combine with other radicals or attack the solvent to form the observed products. In the radiolysis of methyl iodide-pentane solutions, methane appears to be formed by the abstraction of hydrogen from pentane by methyl radicals produced by dissociative electron capture. This production is inhibited by iodine due to the scavenging of methyl radicals to form methyl iodide. The fact that n-propyl chloride added to iodine-pentane solutions does not increase the radical yield as do iodides and bromides is in agreement with the low efficiency reported in the literature for electron capture by chlorides. The $I^{127}(n,\gamma)I^{128}$ process in alkyl iodide-pentane solutions yields a large fraction of the I^{128} in the form of the alkyl iodide solute. Using gas chromatography, I^{128} was found in ten products including methyl, vinyl, ethyl, isopropyl, n-propyl, sec-butyl, n-amyl iodides, and 2- and 3-iodopentane. In the neutron activation of ethyl iodide-pentane solutions containing scavenger iodine, a larger per cent of the organic I^{128} activity was also found in the form of ethyl iodide. Solutions of n-propyl chloride in pentane did not show a large fraction of Cl^{38} activity as n-propyl chloride. The formation of the products containing recoil atoms can be explained by reactions of the recoil atom with radicals produced by ionizing radiation.

22179 ELECTRON PARAMAGNETIC RESONANCE STUDIES OF γ-IRRADIATED POLYPEPTIDES. Russell Cooper Drew (Duke Univ., Durham, N. C.). Dissertation Abstr., 22: 4056-7(May 1962).

Electron paramagnetic resonance studies were made on a group of eighteen γ-irradiated synthetic polypeptides. These compounds are composed of amino acid residues of a single amino acid, joined together through the formation of peptide bonds to create macromolecules of 18-150 residues, with a structure similar to the proteins and the nucleic acids. The polypeptides were studied in a powder form and include samples constructed from the L- and, when available, the DL-configurations of the following amino acids: glycine, sarcosine, alanine, valine, leucine, proline, hydroxyproline, phenylalanine, tyrosine, tryptophan, aspartic acid, glutamic acid, and lysine. The spin resonance pattern was observed for each substance under the following conditions: irradiated and observed in vacuum at 300°K, irradiated and observed in vacuum at 77°K, warming from 77°K to 300°K and returned to 77°K, and opened to air at 300°K. Tracings of the resonance curves obtained in the first 2 are included for all compounds as well as representative spectra illustrating the special effects noted in the others. To clarify the analysis of the spectra observed, the theory of electron paramagnetic resonance was developed, from a derivation of the basic resonance condition, $h\nu = g\beta H$ relating the frequency of the transition, ν, to the g-factor and the magnetic field, H, through the more advanced aspects of configurational interaction and hyperconjugation. Application of the theory to the present case, that of free radicals formed by irradiation of biological material, is stressed. A standard X-band spectrometer system operating at 9.2 Kmcs was used to obtain all curves. This system employs a direct transmission cavity, operating in the TE_{012} mode, with a bolometer and a phase-sensitive lock-in detection system. Sensitivity is such that a minimum of $\sim 10^{15}$ unpaired spins may be detected. Of the polypeptides investigated, only poly-glycine and poly-sarcosine give the doublet spectrum similar to that found for a great number of proteins. Other samples gave characteristically different spin resonance patterns, many of which could be related to a particular free radical structure. These results confirm the postulate that the glycine-type residue is the site of unpaired spin density for proteins which exhibit the typical doublet spectrum. A pronounced "oxygen effect" was noted for all samples when opened to air at 300°K. The observed effects may be classified into three groups: samples which show complete quenching of the resonance within three minutes, those which have their characteristic patterns replaced by a singlet which then decays, and samples which have their resonance patterns unchanged but begin an accelerated decay when opened to air. This behavior is suggested to be the result of the formation of peroxide radicals, X-O-O·, which subsequently decay to form non-radical end products. The degree to which the molecular oxygen may diffuse to the spin sites and form the peroxide radicals and variations in their subsequent decay rates would then explain differences in the observed behavior. A probable correlation is proposed between the spatial configuration of the molecule and the 'oxygen effect' obtained.

22180 RADIATION-INDUCED GRAFT COPOLYMERIZATION TO CELLULOSE. I. GRAFT COPOLYMERIZATION OF METHYL METHACRYLATE TO CELLULOSE INDUCED BY γ-IRRADIATION. Ichiro Sakurada, Toshio Okada, and Yoshihiro Akiyama. Dōitai to Hōshasen, 3: 35-43(Mar. 1960).

Dry filter paper treated in a solution of methyl methacrylate in acetone was irradiated with Co^{60} γ rays in the air. The grafting of methyl methacrylate to dry cellulose was very small, but grafting of methyl methacrylate to cellulose was induced efficiently by irradiating the filter paper in a mixture of methyl methacrylate, acetone, and water. Water accelerated the grafting. Dry cuprammonium rayon, after immersion in a mixture of 5.6 cc of methyl methacrylate and 1.4 cc of water; or 1.05 cc of methyl acrylate, 2.1 cc of water, and 3.85 cc of acetone for 24 hr or longer, was irradiated in the presence or absence of air. The lower the dose rate, the greater the grafting of methyl methacrylate to rayon. The percentage of grafting in the mixture of methyl methacrylate and water increased with increasing temperature. There was an induction period in grafting in air but not in a vacuum. (OID)

22181 RADIATION INDUCED POLYMERIZATION OF VINYL CHLORIDE IN A SOLUTION AT LOW TEMPERATURES. Ioshio Hoshino, Kunio Araki, and Miyozō Yamamoto. Dōitai to Hōshasen, 3: 44-52(Mar. 1960).

The effect of a solvent on radiation-induced polymerization of vinyl chloride at −78°C was examined in methanol, carbon tetrachloride, chloroform, methylene chloride, trichlorethylene, acetone, and tetrahydrofuran. The over-

all activation energy for the polymerization of vinyl chloride was about 4.7 kcal/mole at 4.6×10^4 r/hr. The rates for the polymerization of monomeric vinyl chloride depended greatly on the mole fraction of the vinyl chloride in the solvent. At −78°C, the degree of polymerization of the product was almost constant except for polymerization in a highly diluted methanol solution. The degree of polymerization of the products decreased with an increase in the mole fraction of vinyl chloride in a methanol solution. Tests made on the polymerization of vinyl chloride in methanol in the presence of about 1% of inorganic salts, organic peroxides, and mercaptans did not reveal a striking accelerating effect. (OID)

22182 RADIATION CHEMISTRY OF ETHYLENE OXIDE. Toshio Hoshino, Kunio Araki, and Motonobu Ichino. Dôitai to Hôshasen, 3: 53-61(Mar. 1960).

Radiation-induced polymerization and graft copolymerization of ethylene oxide were studied. When polyvinyl chloride was irradiated for grafting in the presence of a monomer in a vaccum, about 5% increase in weight was observed. For polyethylene, nylon, and polyethylene terephthalate a weight increase of less than 1% was observed. The G-value of radiation-induced polymerization of ethylene oxide ranged from 9 to 21 and decreased at high dose rates. The analysis of the low molecular weight products was made by means of mass spectrometry, gas chromatography, quantitative gas analysis using a Toepler pump, and others. The G-values for the products were $G(H_2)0.7$, $G(CO)0.5$, $G(CH_4)0.6$, $G(C_2H_4)0.5$, and $G(CH_3CHO)$ 2.0. A small amount of ketone was detected, but ethane was not detected. The G-value for the free radical formation measured by the DPPH method was about 6. (OID)

22183 RADIOLYSIS OF METHYL DICHLORIDE. Seizô Okamura and Shigeru Futami. Dôitai to Hôshasen, 3: 62-7(Mar. 1962).

The radiolysis of methyl dichloride was studied by determining the total acid formed by γ irradiation and measured by alkalimetry by the addition of a sufficient amount of water. The amount of the total acid formed was proportional to the radiation dose and dependent on the first order of the dose rate in a vacuum and on the square root in the presence of air. The G-values of $G(H^+)$ were greater in air than in a vacuum. The G-values with the addition of benzoquinone in air were found to be as small as those values obtained in a vacuum. With the addition of DPPH (α,α′-diphenyl-β-picryl-hydrazyl), no trace of acid was found. This suggested that any radical intermediates formed were scavenged by DPPH or any acids formed reacted readily with DPPH molecules. The results of the γ-ray polymerization of styrene in methylene dichloride at low temperatures are discussed also. (OID)

22184 THE HALOGENATING REACTIONS OF POLYMERS INDUCED BY IRRADIATION. II. RADIATION-INDUCED CHLORINATION OF POLYVINYL ALCOHOL. Seizô Okamura, Kôichirô Hayashi, and Masanobu Nishii. Dôitai to Hôshasen, 3: 68-74(Mar. 1960).

Polyvinyl alcohol suspended in carbon tetrachloride and in chloroform in the presence of Cl gas was chlorinated by γ rays. The Cl content in chlorinated polyvinyl alcohol decreased with the concentration of Cl, radiation dose, and the reaction temperature. The G-values were 2×10^5 in chloroform and 600 in carbon tetrachloride. The mobility of Cl atoms in chlorinated polyvinyl alcohol was studied with aniline and sodium ethylate. (OID)

22185 INCREASING THE EFFICIENCY OF RADIATION-INDUCED GRAFT COPOLYMERIZATION BY CHLORINATION OF POLYMERS. Koichiro Hayashi. Dôitai to Hôshasen, 3: 75-6(Mar. 1960).

Graft copolymerization of monomers can be carried out efficiently by slight chlorination with γ irradiation. Studies were made on radiation-induced graft copolymerization of chlorinated polyethylene (methyl methacrylate, styrene, vinyl pyridene, and vinyl pyrrolidone) by the direct method and preirradiation method. Experimental results are tabulated. The efficiency of graft copolymerization of polymers can be increased markedly by ionic irradiation using a weak dosage. (OID)

22186 THE CHANGE IN VISCOSITY OF POLY-α-METHYLSTYRENE AND ITS COPOLYMER BY γ-IRRADIATION. Seizo Okamura, Yoshisue Oishi, and Suzo Kawamura. Dôitai to Hôshasen, 3: 76-8(Mar. 1960).

Viscosity changes of poly-α-methylstyrene and methyl methacrylate-α-methylstyrene copolymer by irradiation were studied by measuring the intrinsic viscosity. Tests showed that the viscosity increased with increasing irradiation dosage and then gradually decreased. (OID)

22187 THE EFFECT OF Co^{60}-γ RAYS ON AQUEOUS CHLORALHYDRATE. Yôko Murata, Ienari Tachikawa, and Masaharu Kondo. Dôitai to Hôshasen, 3: 200-7(Apr. 1960).

When aqueous chloralhydrate was irradiated by Co^{60} γ rays, the main product of radiolysis was HCl. The production of HCl was proportional to the dose at a given dose rate as was found by Andrews and Freeman. A high G γ value of HCl indicated that the reaction was a chain reaction, and the OH radical was one of the chain initiators. The dependence of the dose rate and concentration on the G value was determined. (OID)

22188 THE DEGRADATION OF CARBOXYMETHYLCELLULOSE BY γ-IRRADIATION. Hiroshi Sobue, Yoneho Tabata, and Akio Fujimura. Dôitai to Hôshasen, 3: 303-9(Sept. 1960).

Specimens of CMC and NaCMC were irradiated as solids and in aqueous solutions with Co^{60} γ rays at room temperature, and the direct and indirect irradiation effects were studied. The viscosities and infrared spectra measured showed that degradation occurred in a random fracture of the main chain because the apparent energies of the main chain fracture of the samples for NaCMC in a vacuum, air, and an aqueous solution were 40, 20, and 0.4 ev, respectively. It was concluded that the scission of the main chain depends on the chain reaction with regard to the existence of water. (OID)

22189 RADIATION-INDUCED GRAFT COPOLYMERIZATION TO CELLULOSE. III. ACETOLYSIS OF GRAFT COPOLYMERIZATION OF CELLULOSE WITH STYRENE. Yoshio Kobayashi. Dôitai to Hôshasen, 3: 310-15(Sept. 1960).

Samples of 240 mg were soaked first in 1% acetic acid and then irradiated with Co^{60} γ rays up to 1.74×10^6 r at the rate of 1.06×10^5 r/hr. The graft copolymer obtained showed an average degree of polymerization of 1.91×10^4, and its molecular weight, determined by viscometry, was above 1.8×10^6 which was much higher than that of polymerization in solution. (OID)

22190 RADIATION-INDUCED GRAFT COPOLYMERIZATION OF POLYVINYL ALCOHOL. V. THERMAL GRAFTING OF METHYL METHACRYLATE TO POLYVINYL ALCOHOL FILMS γ-IRRADIATED IN AIR. Ichiro Sakurada, Toshio Okada, and Eiko Kugo. Dôitai to Hôshasen, 3: 316-28(Sept. 1960).

The samples prepared by irradiating dry PVA films be-

tween 0.066 to 0.149 mm were irradiated first in air at 0.2 to 0.13 Mr/hr up to 46 to 9.1 Mr, respectively, with γ rays at temperatures between 12 to 20°C, immersed in various mixtures of monomer solutions, and evacuated to a pressure less than 10^{-4} mm Hg. Graft copolymerization was observed when the samples were heated between 30 to 80°C for 22 to 24 hr. The grafting efficiency was 97% at 40°C but decreased to 64% at 80°C. It was concluded that active centers of PVA films were responsible for diperoxides as well as the hydroperoxides and trapped radicals. Grafting appeared only in the presence of water. (OID)

22191 RADIATION-INDUCED ANIONIC POLYMERIZATION IN THE PRESENCE OF AMINES OR AMIDES AS SOLVENTS. Seizo Okamura. Dôitai to Hôshasen, 3: 333-45 (Sept. 1960).

Experimental results showed the rate of radiation-induced polymerization of MMA at −78°C was increased in the presence of isopropylamine in comparison to styrene, and these rates were found to be 10 times greater than those obtained at 30°C using 4.3 kcal/mole for the activation energy. The irregular dependence of the polymerization rate on the concentration of the monomer, radiation dose, and the accelerating effects of isopropylamine for MMA and nitrile, but not for styrene strongly, suggested the occurrence of the ionic polymerization mechanism. The reaction scheme can be considered as: (1) $M \rightsquigarrow M^+ + e$; (2) $A + e \rightarrow A^-$; (3) $A^- + M \rightarrow AM^-$; and (4) $A(M)_n^- \rightarrow A(M)_{n+1}^-$, where M, A, and e represent the monomer, the amine (or amide), and the electron, respectively. (OID)

22192 RADIATION-INDUCED POLYMERIZATION OF DIKETENE. Yasuhia Kitanishi, Koichiro Hayashi, and Seizo Okamura. Dôitai to Hôshasen, 3: 346-7 (Sept. 1960).

Polymer yields of 5.7% and 6.0% were obtained by irradiating 10 ml of diketene with Co^{60} γ rays at 7.8×10^3 r/hr for 17.6 hr in a vacuum and in air, respectively, at −78°C, and then washing with methanol and drying in a vacuum at 40°C for 48 hr. The results showed that oxygen did not affect polymerization. The polymer also showed a corresponding percentage composition and a distinct melting point at 114°C. Other analyses were made also on equivalent mixtures of diketene–acrylonitrile or styrene. The experimental results suggested that the polymerization of diketene is caused by an ionic mechanism. (OID)

22193 RADIATION-INDUCED PARTIAL IONIC (PARTIAL RADICAL) POLYMERIZATION OF ISOPRENE. Ryosuke Shimozawa, Yoneho Tabata, and Hiroshi Sobue. Dôitai to Hôshasen, 3: 373-8 (Nov. 1960).

γ-ray induced polymerization of isoprene was investigated in the temperature range from −78°C to 40°C. The effects of additives, temperature, and dose rate on the polymerization rate were studied in this temperature range. 1,1-Diphenyl-2-picrylhydrazyl strongly retarded polymerization at high temperatures, while pyridine retarded it at low temperatures. A linear relationship could not be observed in Arrhenius' plot of the polymerization rate. The over-all polymerization rate was separated into radical and ionic contributions. The structure of the polyisoprene obtained at −78°C was similar to that of the polyisoprene obtained by cationic catalysis. The radiation-induced polymerization of isoprene was predominantly a radical one. At intermediate temperatures, both the cationic and radical mechanisms were operative concurrently. (OID)

22194 RADIATION-INDUCED GRAFT COPOLYMERIZATION TO POLYVINYL ALCOHOL. VII. THERMAL GRAFTING OF STYRENE TO PRE-IRRADIATED POLYVINYL ALCOHOL FILMS. Ichiro Sakurada, Toshio Okada, and Eiko Kugo. Dôitai to Hôshasen, 3: 379-97 (Nov. 1960).

In most cases, no grafting occurred when a styrene solution was used for grafting without the addition of water. When a methanol solution of styrene was used for grafting, grafting occurred smoothly at a higher temperature than 40°C without the addition of water. Methanol was the most effective solvent for the grafting. Oxygen in air had a strong inhibiting or retarding effect on graft copolymerization. A temperature higher than 80°C had to be used for grafting in the presence of air. Graft copolymerization was carried out in vacuo. The optimum temperature of grafting was 50°C. The initial rate of grafting was higher at higher temperatures, but the amount of grafting after 24 hr was highest at about 50°C. The behavior of air-irradiated PVA films subjected to graft copolymerization was quite similar to that for films irradiated in a vacuum. The films were brought in contact with air for 3 hr at room temperature after vacuum irradiation, and then subjected to graft copolymerization at 50°C for 24 hr. The trapped radicals which were stable in air at room temperature played a most important role in grafting in both cases. The effect of the dose rate on the rate of grafting was small, not only for vacuum irradiation, but also for air irradiation. (OID)

22195 γ-RAY INDUCED POLYMERIZATION OF METHYL METHACRYLATE IN THE PRESENCE OF POLYVINYL ACETATE. Seizo Okamura, Koichiro Hayashi, and Yasuhisa Kitanishi. Dôitai to Hôshasen, 3: 398-405 (Nov. 1960).

The polyvinyl acetate added was considered as a solvent of the solution, and to compare this with polyvinyl acetate, an equivalent amount of ethyl acetate, which had the same structure as the monomer unit of polyvinyl acetate, was used. The rate of the free radical production of ethyl acetate is a linear function of the chemical composition of the mixture. The ratio of the rate of solution polymerization to the rate of bulk polymerization (R_p/R_{p_0}) was decreased slightly by the small amount of polyvinyl acetate, and then it increased rapidly with an increasing amount of polyvinyl acetate. The speed of this increase was greater in the higher molecular weight polymer system than in the case of the lower polymer. This rapid increase was attributed to the gel effect. The degree of polymerization of polyvinyl acetate was only slightly influenced by the decrease of the ratio, R_p/R_{p_0}. This negative acceleration phenomenon at a low concentration of the polymer was not considered to be due to the energy transfer from methyl methacrylate to polyvinyl acetate, but to the coil effect of the polymer chain in the solution. (OID)

22196 RADIATION-INDUCED GRAFT COPOLYMERIZATION TO POLYVINYL ALCOHOL. VIII. THE GRAFTING OF STYRENE TO PRE-IRRADIATED POLYVINYL ALCOHOL FILMS IN THE PRESENCE OF FERROUS IONS. Ichiro Sakurada, Toshio Okada, and Eiko Kugo. Dôitai to Hôshasen, 3: 406-15 (Nov. 1960).

The grafting of styrene in the air or in a vacuum to pre-irradiated polyvinyl alcohol films was carried out in the presence of ferrous ions at different temperatures. Although the effect of ferrous ions on the rate of graft copolymerization was not so significant as in the case of grafting of methyl methacrylate, ferrous ions had a favorable effect on graft copolymerization in the air at lower temperatures. Grafting occurred only slightly when graft copolymerization was carried out under 80°C in air in the absence of ferrous ions, but it occurred smoothly in the presence of ferrous ions. The behavior of vacuum-irradiated PVA

films subjected to graft copolymerization was similar to that of air-irradiated PVA films. (OID)

22197 PROGRESS IN HIGH-POLYMER RADIATION CHEMISTRY. Hiroshi Sobue. Dôitai to Hôshasen, 3: 453-63(Feb. 1961).

Current progress on the radiation chemistry of the gas-phase, liquid-phase, and solvent- and solid-phase polymerization as well as graft copolymerization and irradiation effects on polymers are discussed. (OID)

22198 IMPROVEMENT OF POLYOLEFIN FIBERS BY IRRADIATION WITH Co^{60} γ-RAYS IN SULFUR DIOXIDE. Noburu Yamada, Tamio Arakawa, and Satoru Tsuda. Dôitai to Hôshasen, 3: 483-7(Feb. 1961).

Tests on polymerizing propylene with SO_2 by Co^{60} γ irradiation showed that the sulfur groups in chains or branches of the copolymer molecules have a good affinity for dye. Hence, the dyeability of synthetic fibers may be improved by using this ionizing radiation method. Tests were made with the 120-c Co^{60} facilities at the Hiroshima Univ. on nylon, Tetron, Orlon, polyvinyl alcohol, polyvinyl chloride, polyethylene, and polypropylene fibers at a dose rate of 5×10^4 r/hr. Results showed that the existence of air and SO_2 during irradiation promoted the dye properties of polyolefin fibers with Celliton Fast Red GG and Dia Basic Magenta when doses were above 10^5 r, and above 10^4 r for polypropylene and polyethylene fibers. The mechanical properties of polyolefin fibers γ-irradiated in a vacuum and in SO_2 are compared. (OID)

22199 CHEMICAL DOSIMETRY OF HIGH LEVEL GAMMA-RAYS. Akibumi Danno. Dôitai to Hôshasen, 3: 488-95(Feb. 1961).

Experimental results with a N_2 saturated ferrous sulfate or a ferrous cupric sulfate dosimeter for high doses using a chemical method with a 10-kc Co^{60} source are discussed. Test tubes with glass stoppers were filled with the samples so that no bubbles remained in the tubes and irradiated with a cylindrical γ ray source at room temperature. The yield of Fe^{+3} or Fe^{+2} was analyzed by the photometric or volumetric method. The N_2-saturated solution can be used for measuring doses between 3 and 5×10^{18} r. The addition of F^- or SO_4^{-2} suppressed the Fe^{+3} reduction and increased the dosage range considerably. The low $G(Fe^{3+})$ and the independence of the O_2 of the ferrous-cupric sulfate system increased the range for measuring doses up to 8×10^7r. (OID)

22200 ISOTOPE DILUTION STUDIES ON THE RADIOLYSIS OF BENZOIC ACID IN AN AQUEOUS SOLUTION. Akibumi Danno. Dôitai to Hôshasen, 3: 496-505(Feb. 1961).

The dependency of the radiation-induced yields of salicylic acid and biphenyldicarboxyl acids from aqueous benzoic acid (carboxyl-C^{14}) solutions free of or saturated with oxygen were studied using a 10-kc Co^{60} source. The salicylic acid yields in the dose range from 2.7×10^4 to 3.9×10^5 r/hr against a constant dose of 3.8×10^6 r indicated that the yield decreased with increasing rate in both systems. The yield obtained from the oxygen system was greater than that obtained from the system without oxygen The biphenyldicarboxylic acids induced were noticeable only in the oxygen-free solution, and the yields showed a linear relationship with respect to the dose absorbed for irradiation at a constant 1.6×10^5 r/hr. The mechanism of the radiation-induced reaction is discussed based on these results. (OID)

22201 RADIATION-INDUCED POLYMERIZATION OF β-PROPIOLACTONE. S. Okamura. Dôitai to Hôshasen, 3: 510-12(Feb. 1961).

Test results showed that the optimum conditions for irradiating purified β-propiolactone large single crystals with Co^{60} γ rays in a vacuum were $<10^{-3}$ mm at −78°C. The polymerization rate decreased slightly for irradiation in air and sharply in the liquid phase. The polymer obtained, which had a composition of 51.54, 5.85, and 42.61% for C, H, and O, respectively, had a distinct melting point at 121°C, was not soluble in the usual solvents at room temperature, but dissolved easily in hot formic acid and benzaldehyde. (OID)

22202 RADIATION-INDUCED COPOLYMERIZATION OF ETHYLENE OXIDE AND ACRYLONITRILE. S. Okamura, K. Hayashi, and H. Watanabe. Dôitai to Hôshasen, 3: 512-13(Feb. 1961).

Purified ethylene oxide was irradiated with acrylonitrile in a vacuum ($<10^{-4}$ mm) with Co^{60} γ radiation. Analysis showed the copolymerization yield obtained was a function of the monomer composition with respect to the temperature. It was concluded that the ethylene oxide content in the copolymer increased with decreasing irradiation temperature and acrylonitrile content in the monomer mixture. (OID)

22203 THE POLYMERIZATION OF ACETYLENE BY RADIATION. Yoneho Tabata. Genshiryoku Kôgyô, 7: No. 2, 53-6(Feb. 1961).

Irradiated gaseous acetylene produces cuprene and benzene. When pure liquefied acetylene was irradiated at −160°C, a yellowish-brown polyacetylene was formed. This reaction was an ionic reaction. This liquid-phase polymer was believed to be a cis-type polyacetylene. At −196°C, solid acetylene was irradiated, and polyacetylene was formed. This solid-phase polymer was brownish-red and believed to be a trans-type polyacetylene. In both the liquid-phase and the solid-phase reactions, benzene did not form. (OID)

22204 THE EFFECT OF γ-IRRADIATION ON THE MICROORGANISMS IN JAPANESE FOODS AND ITS APPLICATION TO STERILIZATION. II. THE EFFECT OF γ-IRRADIATION ON THE STERILIZATION AND STORAGE OF RAW SWEET POTATOES AND ITS APPLICATION TO ALCOHOL PRODUCTION. Shiro Teramoto. Hakkô Kôgaku Zasshi, 37: 107-10(Mar. 1959).

Results indicated that all rot bacteria and C. fimbriata of sweet potatoes could be destroyed at a dosage level of 3×10^6 r. It was concluded that it was possible to sterilize and store raw sweet potatoes for alcohol production because the amylolysis of γ-irradiated sweet potatoes did not effect the sugar content or alcohol fermentation rates. (OID)

22205 THE EFFECT OF γ-IRRADIATION ON THE MICROORGANISMS IN JAPANESE FOODS AND ITS APPLICATION TO STERILIZATION. III. THE MECHANISM OF THE FORMATION OF MERCAPTAN AND ACETOIN IN γ-IRRADIATED SAKE. Shiro Teramoto. Hakkô Kôgaku Zasshi, 37: 231-3(June 1959).

A study was made on undesirable side effects encountered in the sterilization process by γ-irradiation of soya and sake. The content of mercaptan and acetoin in sake and soya at a dosage level of 1.0×10^5 r increased by 20%. It was observed that the formation of mercaptan and acetoin in irradiated sake was due to the decomposition of amino acids containing S and by acetoin condensation and radical reaction of the acetaldehyde present. (OID)

22206 THE EFFECT OF γ-IRRADIATION ON THE MICROORGANISMS IN JAPANESE FOODS AND ITS APPLICATION TO STERILIZATION. IV. THE CHANGE IN AMINO ACIDS IN SAKE IRRADIATED BY γ-RAYS. Koichi Yoshikawa and Hisaharu Taguchi. Hakkô Kôgaku Zasshi, 38: 531-6(Nov. 1960).

Samples of alcoholic and aqueous amino acid solutions were irradiated by γ rays from a 1400-c Co^{60} source at 2.4×10^4 r/hr up to 2×10^5 to 3×10^6 r at 20°C. An unpleasant favor became distinct at the 2×10^5 r and 5×10^5 r levels for aqueous and alcoholic solutions, respectively. The former also exhibited a stronger odor. Tabulated yields of ammonia and volatile amine showed that they increased with increasing dosage and that the increased amounts were greater in the aqueous solutions than in the alcoholic ones. This indicated that alcohol exerts a protective action against amino acids. (OID)

22207 THE EFFECT OF γ-IRRADIATION ON THE MICROORGANISMS IN JAPANESE FOODS AND ITS APPLICATION TO STERILIZATION. V. THE CHANGE IN THE ABSORPTION SPECTRA OF SAKE AND ARTIFICIAL SAKE BY γ-IRRADIATION. Koichi Yoshikawa and Hasaharu Taguchi. Hakkô Kôgaku Zasshi, 38: 606-11(Dec. 1960).

When sake and artificial sake were irradiated with γ rays from a 1400-c Co^{60} source at the rate of 2.5×10^4 r/hr up to 2×10^5 to 2×10^6 r, the color tone of the former increased while the latter decreased. This phenomenon was explained by a study of the absorption spectrum which showed that the different amino-acid concentrations and the decomposition of the artificial coloring were responsible for the decrease in color. The color tone of sake increased because of the presence of 2,4-Dopa produced from tryptophan and tyrosene by γ irradiation. (OID)

22208 THE EFFECT OF γ-IRRADIATION ON THE MICROORGANISMS IN JAPANESE FOODS AND ITS APPLICATION TO STERILIZATION. VI. THE CHANGE IN THE OXIDATION-REDUCTION POTENTIALS OF SAKE AND ARTIFICIAL SAKE BY γ-IRRADIATION. Koichi Yoshikawa and Hisaharu Taguchi. Hakkô Kôgaku Zasshi, 38: 612-15(Dec. 1960).

The samples were irradiated by a 1400-c Co^{60} γ-ray source at the rate of 2.5×10^4 r/hr up to 2×10^5 to 3×10^6 r. The oxidation-reduction potentials of sake and the artificial sake were increased by γ irradiation. However, the rH value of the irradiated sake was lower than the irradiated artificial sake at various dosage levels and the unirradiated samples. The changes that occurred were assumed to have been induced by γ irradiation. (OID)

22209 THE EFFECT OF γ-IRRADIATION ON THE MICROORGANISMS IN JAPANESE FOODS AND ITS APPLICATION TO STERILIZATION. VII. THE CHANGES IN SOY SAUCE BROUGHT ABOUT BY γ-IRRADIATION. Koichi Yoshikawa and Hisaharu Taguchi. Hakkô Kôgaku Zasshi, 39: 69-74(Feb. 1961).

The changes in the components responsible for the disagreeable odor, oxidation-reduction potential, and the absorption spectra of γ-irradiated soy sauce were studied. Soy sauces of a mild brand (koikuchi) and a strong brand (usukuchi) were irradiated with a 1400-c Co^{60} γ ray source at 2.5×10^4 r/hr up to 2×10^5 to 2×10^6 r. Tabulated results showed that the ammonia, amine, and aldehyde contents increased from 420 to 710, 61.2 to 101 r/ml and 80.4 to 120.5, respectively, for 0 to 2×10^6 r in the case of the milder brand. Similar results were observed for the stronger brand. The rH values also increased from 14.6 to 15.8 for usukuchi and from 14.3 to 15.9 for koikuchi. The size of the increment for usukuchi was greater than that of koikuchi in all cases. (OID)

22210 THE EFFECT OF γ-IRRADIATION ON THE MICROORGANISMS IN JAPANESE FOODS AND ITS APPLICATION TO STERILIZATION. VIII. THE EFFECT OF γ-IRRADIATION ON RICE FOR SAKE BREWING. Koichi Yoshikawa and Hisaharu Taguchi. Hakkô Kôgaku Zasshi, 39: 74-7(Feb. 1961).

The γ-irradiation effects on the physical and chemical properties in rice were studied. The samples were irradiated by a 1400-c Co^{60} γ-ray source at 2.5×10^4 r/hr up to 1.5×10^5 to 2×10^6 r. Complete sterilization was obtained at a dosage of 10^6 r. The intrinsic viscosity of the rice starch decreased with increasing dosages. The nitrogenous components decreased slightly with increasing dosages. No obvious effects were observed in the enzyme activities from the rice-koji made from irradiated rice, or in the analytical results from "moto." (OID)

22211 THE UTILIZATION OF GLASSES CONTAINING Cs^{137} FOR THE PREPARATION OF SEALED RADIOACTIVE SOURCES. III. SEALED SOURCES. G. Vormum and D. Schoenberg (Institut für Medizin und Biologie der Deutschen Akademie der Wissenschaften, Berlin and Arbeitsbereich Angewandte Isotopenforschung, Berlin). Isotopentechnik, 2: 20-2(Jan. 1962). (In German)

The preparation and processing of glasses containing Cs^{137} is described. The glass components are Li_2O, BeO, and B_2O_3. The processing proceeds in two steps, first extrusion of glass wires and then sealing the glass in refined steel caps. The evaporation loss in the fusion process and the solubility of the source in water were determined. (tr-auth)

22212 SPECIAL QUESTIONS ON THE PRODUCTION OF RADIOACTIVE NUCLIDES. R. Muenze (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Isotopentechnik, 2: 23-7(Jan. 1962). (In German)

After a brief review of the nuclear reactions essential for the production of radioisotopes and of the kinetics of radioisotope formation, the technology is described. The preparation of carrier-free radioisotopes—S^{35}, F^{18}, and I^{132}—is emphasized. (tr-auth)

22213 CONDUCTING THIN FILMS FORMED BY ELECTRON BOMBARDMENT OF SUBSTRATE. R. W. Christy (Space Technology Labs., Inc., Los Angeles). J. Appl. Phys., 33: 1884-8(May 1962).

A technique for depositing thin films has been investigated. The method consists in decomposing molecules on a substrate by bombarding them with electrons, leaving metal atoms on the substrate. The film is formed selectively on the area of the substrate struck by the electrons. Stannous chloride is decomposed to metallic tin by electrons of about 200 ev energy. Tetrabutyltin decomposition is also studied. With the current densities used, tetrabutyltin is only partially decomposed, to form a semiconducting polymer film. Theoretical considerations suggest that the method should be applicable to a wide variety of metals. (auth)

22214 THERMOLUMINESCENCE FROM GAMMA-IRRADIATED BIOCHEMICALS. INVESTIGATION OF EMISSION SPECTRA. C. J. Weinberg (Oak Ridge National Lab., Tenn.). D. R. Nelson, J. G. Carter, and L. G. Augenstine. J. Chem. Phys., 36: 2869-79(June 1, 1962). (BNL-5782)

Crystalline powders of the aromatic amino acids and the enzyme trypsin were exposed at 77°K to Co^{60} γ rays, and the spectral distribution (between 3000 and 6500 A) of the thermoluminescence emitted upon subsequent heating was determined using band-pass filters. At a temperature corresponding to a particular peak in a plot of emission intensity vs T, a large fraction of the emission (except from phenylalanine) consisted of one characteristic spectral component. In general, the proportion of emission at the longer wavelengths increased with increasing temperature. The thermal-activation energies of thermoluminescence,

estimated from plots of $\ln I_T$ vs 1/T (about 0.2 ev for the amino acids and 0.1 ev for trypsin), were lower than similar determinations at comparable temperatures for alkali halide crystals. The γ induced thermoluminescence from amino acid crystals was composed of longer wavelengths than the uv-excited fluorescence (at room temperature) or long-lived phosphorescence (at 77°K). The possible limitations within which lattice imperfections might account for these effects are discussed briefly. The spectral results for trypsin provided additional evidence that, in accord with previous predictions, at least some of the electronic rearrangements arising from γ interactions become preferentially localized in only a restricted number of configurations. The metastable species which persisted at 77°K likely depend upon the native conformation of the protein, and the available evidence suggested that the decay of an excited triplet state of tryptophan accounts for the majority of the trypsin emission. Even so, the activation energies and spectra indicated that the initial trapping and untrapping does not occur at the aromatic amino acid residues. Accordingly, mechanisms were considered whereby electronic rearrangements at other sites in trypsin could lead to the excitation of an aromatic residue followed by phosphorescence from a tryptophan residue. (auth)

22215 DECOMPOSITION OF (CH_3Xe^{131}) FOLLOWING THE NUCLEAR DECAY OF CH_3I^{131}. T. A. Carlson and R. M. White (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 36: 2883-7(June 1, 1962).

The charged fragments resulting from the decay of CH_3I^{131} were measured by a specially designed mass spectrometer. In 70% of the decays, the parent ion CH_3Xe^+ remained intact in direct contrast to the decay of CH_3T in which hardly any CH_3He^+ was found. More than 20 other ions were also detected including the doubly charged methyl xenon $(CH_3Xe)^{+2}$. Their relative abundances are discussed in terms of excitation resulting from the sudden change in nuclear charge, and from multiple Auger processes in cases where internal conversion accompanies the decay. (auth)

22216 RADIOLYSIS OF ETHANE-1,1,1-d_3. Louis J. Stief and P. Ausloos (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 36: 2904-10(June 1, 1962).

The radiolysis of CH_3CD_3 was investigated with particular emphasis on the effect of pressure, temperature, and addition of xenon on the molecular hydrogen formation. The hydrogen formed by molecular detachment was determined by irradiating CH_3CD_3 in the presence of C_2H_4, NO, O_2, or I_2. The formation of molecular hydrogen in the unimolecular decomposition of the parent ion and in the decomposition of the neutral excited ethane molecule are considered. Methane formed in the presence of scavengers may be attributed to an ion-molecule reaction or to an intramolecular process similar to that proposed in the direct photolysis of ethane. Evidence is presented for occurrence of a reaction producing ethylene in addition to the one in which molecular hydrogen accompanies the formation of ethylene. (auth)

22217 FREE RADICALS IN IRRADIATED NYLON. Y. Shinohara and D. Ballantine (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys., 36: 3042-9(June 1, 1962). (BNL-5271)

Gamma irradiation of undrawn filaments of nylon 6 produces several different free radicals whose concentration, ESR pattern, and lifetimes are affected by irradiation temperature, dose, storage conditions, and crystallinity. A five-peak short-lived species, measured at liquid-nitrogen temperature, predominates at low doses, low irradiation temperatures, and is believed to be a free radical associated with the carbon α to the amide nitrogen. A broad singlet is found at higher doses and is believed to be a radical in a conjugated system which includes the amide group. The experimental results are explained in terms of a free radical which is capable of migrating by a hydrogen-atom transfer process. (auth)

22218 PULSE RADIOLYSIS STUDIES. I. TRANSIENT SPECTRA AND REACTION-RATE CONSTANTS IN IRRADIATED AQUEOUS SOLUTIONS OF BENZENE. Leon M. Dorfman, I. A. Taub, and R. E. Buehler (Argonne National Lab., Ill.). J. Chem. Phys., 36: 3051-61(June 1, 1962).

The radiation chemistry of aqueous benzene solutions was studied by the electron-pulse radiolysis technique. Ultraviolet absorption spectra of some of the transient species were recorded by synchronized flash-absorption spectroscopy. The elementary reactions occurring were observed by fast photoelectric recording of the transient optical density. A transient spectrum having a broad absorption with a strong maximum at 313 mμ was observed. On the basis of both spectrographic and kinetic evidence this spectrum is assigned to the hydroxycyclohexadienyl radical, $(OH)C_6H_6^{\cdot}$. The molar extinction coefficient was estimated to be $\epsilon_{3130} = 3500 \pm 800\ M^{-1}cm^{-1}$. A number of substituted cyclohexadienyl radicals were observed in aqueous solution as well as in pure benzene and chlorobenzene. A second transient observed in oxygenated aqueous benzene solution showed an absorption shifted to lower wavelengths. This was attributed to the hydroxycyclohexadienyl peroxy radical, $(OH)C_6H_6O_2^{\cdot}$. Absolute rate constants were determined at 23°C for the following reactions: $OH + C_6H_6 = (OH)C_6H_6^{\cdot}$, $(4.3 \pm 0.9) \times 10^9\ M^{-1}sec^{-1}$; $OH + C_6D_6 = (OH)C_6D_6^{\cdot}$, $(4.7 \pm 0.9) \times 10^9\ M^{-1}sec^{-1}$; and $(OH)C_6H_6^{\cdot} + O_2 = (OH)C_6H_6O_2^{\cdot}$, $(5.0 \pm 0.6) \times 10^8\ M^{-1}sec^{-1}$. The yield of phenol in oxygenated solution was found to decrease continuously with increasing pulse intensity. At the highest intensity used, $G(C_6H_5OH) = 0.19$ molecules/100 ev. At the lowest pulse intensity used, $G(C_6H_5OH) = 1.9$ molecules/100 ev, which approaches the values found in steady irradiations. Some additional phenol was formed in slow post-irradiation reactions. Diphenyl was identified as a product in the deaerated system by gas chromatographic analysis. Its formation was largely the result of post-irradiation reactions, the initial yield being substantially lower than previously reported. The mechanism of the radiation chemical reaction in both deaerated and oxygenated solutions is discussed on the basis of the conclusion that the hydroxyl radical enters the ring to form the hydroxycyclohexadienyl radical. (auth)

22219 THE ROLE OF PRIMARY PROCESSES IN THE EFFECT OF pH DURING THE RADIOLYSIS OF WATER. Robert Schiller (Central Research Inst. of Physics, Budapest). J. chim. phys., 59: 267-71(Mar. 1962). (In French)

The effect of pH in the radiation chemistry of aqueous solutions is studied in the light of primary processes. In developing the basic idea of the theory of radical diffusion, the possibility of the capture of electrons by H_3O^+ leading to a change in the spatial distribution of H atoms formed in the first place is discussed. The solutions of the differential equation of the "ionization cluster" for different initial distributions are combined for each product of the radiolysis of water as a function of pH, whereas the coefficient coming from the combination of solutions is connected with the concentration of H_3O^+. The theoretical yields are in good agreement with the known experimental results. (tr-auth)

22220 THE THERMAL DECOMPOSITION OF IRRADIATED PERMANGANATES. E. G. Prout and P. J. Herley (Rhodes Univ., Grahamstown, South Africa). J. Phys. Chem., 66: 961-7 (June 1962).

The thermal decomposition of unirradiated Li and Na permanganates, and Li, Na, and Cs permanganates preirradiated by γ rays, was investigated. A comparative study of the magnitude of the irradiation effect with the permanganates of the alkali metals precluded the creation of incipient nuclei by the Compton recoil effect. The formation of essential sites was assumed to occur as a result of cationic displacement following multiple ionization by γ rays. (auth)

22221 DEUTERIUM EXCHANGE ON SILICA GEL INITIATED BY COBALT-60 IRRADIATION. Harold W. Kohn (Oak Ridge National Lab., Tenn.). J. Phys. Chem., 66: 1017-21 (June 1962).

The irradiation-induced exchange of deuterated silica gel with methane and with hydrogen was studied with Co^{60} gammas, and the yields of H_2, HD, D_2, and CH_3D were measured. The G-values for HD and D_2 from the hydrogen reaction based on energy absorbed by the gel were 1.5 to 1.8 and 0.6 to 1.0, respectively. Deuterated product yield increased with cumulative dose. The high D_2 yield could be suppressed either by degassing the gel at higher temperatures before irradiation, or by lowering the temperature of the radiation reaction. These treatments left the HD yield virtually unaffected. Radioinduced exchange with methane gave low (< 0.4) yields for all hydrogen species and somewhat greater (0.6 to 1.6) yields for CH_3D, which increased and then decreased with increasing degassing temperature up to 585°, showing a maximum near 400°. The hypothesis that radiation-produced ions on the gel initiate reaction is discussed. (auth)

22222 RADIOLYSIS OF CHLORO-, BROMO-, AND IODOBENZENES WITH COBALT-60 γ-RAYS. Sang Up Choi and John E. Willard (Univ. of Wisconsin, Madison). J. Phys. Chem., 66: 1041-9 (June 1962).

G-values were determined for the products of radiolysis of liquid C_6H_5Cl, C_6H_5Br, and C_6H_5I at room temperature and 100°, and in the presence of radical scavengers. The inorganic products are HCl from C_6H_5Cl, HBr and Br_2 from C_4H_5Br, and primarily I_2 from C_6H_5I. G_{H_2} is $< 10^{-2}$. Organic products include C_6H_5, $C_6H_5C_6H_5$, $C_6H_4X_2$, and C_6H_5-C_4H_4X. Apparent activation energies for the formation of all of the products are ≤ 3 kcal/mole. The yields of organic products are relatively insensitive to halogen scavengers. G-values for conversion of the aromatic halide to new products of molecular weight up to and including the halobiphenyls are about 2.3, 4.0, and 5.3 for the iodide, bromide, and chloride, respectively, while the corresponding values for exchange with radioiodine are approximately four equivalents per 100 ev in each case. In the radiolysis of C_6H_5Br and C_6H_5I, metastable products with high absorbancy indices at 3750 and 4200 Å, respectively, which disappeared at room temperature with a first-order rate constant of about 0.1/hr, and much more rapidly at 90°, were formed. Intense illumination of $C_6H_5Br-Br_2$ solutions with light absorbed by bromine did not form the metastable species. The results reported for the aromatic halides are compared with known data for alkyl halides. (auth)

22223 THE EFFECT OF HYDROGEN IODIDE ON THE RADIOLYSIS OF CYCLOHEXANE-d_{12}. James R. Nash and William H. Hamill (Notre Dame Univ., Ind.). J. Phys. Chem., 66: 1097-9 (June 1962).

The γ radiolysis of dilute solutions of hydrogen iodide in cyclohexane-d_{12} led to G(D-atom) $\cong$ 1.7. There was a large $G(H_2)$, amounting to 2.2 molecules/100 ev at 0.7 mole % HI. This effect, attributed to dissociative electron attachment, seriously complicated using halogens or halides as H-atom and free radical scavengers. (auth)

22224 RADIATION CHEMISTRY OF OCTAMETHYLCYCLOTETRASILOXANE. Clarence J. Wolf and A. C. Stewart (Parma Research Lab., Ohio). J. Phys. Chem., 66: 1119-24 (June 1962).

The effects of dose, dose rate, temperature, and scavengers (iodine and oxygen) on the γ induced gas and polymer formation from octamethylcyclotetrasiloxane were investigated. In the absence of scavengers, the hydrogen, methane, and ethane yields were 0.89, 2.08, and 0.29 molecules per 100 ev, respectively. The hydrogen and ethane yields were independent of the scavenger concentration (between 2 and 11×10^{-3} molar) and of the dose: their yields were 0.57 and 0.29 molecule per 100 ev, respectively. The methane yield was quite sensitive to both iodine concentration and dose. Two specific types of higher molecular weight products were found cyclic dimers and linear polydimethylsiloxanes. The former were produced by a temperature independent process, while the latter were formed with an apparent activation energy of 7 kcal/mole. (auth)

22225 RADIATION-POLYMERIZATION OF ETHYLENE: EVIDENCE FOR ION-MOLECULE CONDENSATION. C. D. Wagner (Shell Development Co., Emeryville, Calif.). J. Phys. Chem., 66: 1158-62 (June 1962).

Ionizing radiation polymerizes ethylene at −196° to low molecular weight, monoölefinic, mainly branched polymers. Polymerization of a mixture of C_2D_4 and C_2H_4 gives polymer molecules containing deuterium in multiples of four, demonstrating that the initiating species contains four hydrogen atoms. Structure of the C_4, C_6, and C_8 products showed that propagation can occur from either of at least two carbons in the propagating species, no skeletal isomerization occurs, and hydrogen atom migration is limited. This type of polymerization is believed to be initiated by the molecule ion, $C_2H_4^+$ with propagation by ion-molecule condensation, and termination by electron recombination. However, a mechanism involving excited molecule condensation is not excluded. (auth)

22226 SURFACE CARBONIUM IONS PRODUCED BY IRRADIATING SILICA GEL. Harold W. Kohn (Oak Ridge National Lab., Tenn.). J. Phys. Chem., 66: 1185-6 (June 1962).

Experiments were carried out which indicate that positive ions in the gel formed during the irradiation of silica gel can transfer their charge to adsorbed species, thus leading to stable carbonium ions. (M.C.G.)

22227 INTERMOLECULAR ENERGY TRANSFER IN POLYETHYLENE–POLYBUTADIENE BLENDS DURING γ-IRRADIATION. Morton A. Golub (Stanford Research Inst., Menlo Park, Calif.). J. Phys. Chem., 66: 1202-3 (June 1962).

It was observed by Dole and Williams that in gamma-irradiation of a polyethylene (PE)–cis-polybutadiene (CPB) blend at 142°C, the PE was protected to some extent against decay of vinyl groups and evolution of hydrogen while the CPB underwent cis-trans isomerization. The amount of energy which must be transferred to CPB to bring about its enhanced isomerization was compared with the amount of energy that had to be removed from PE to produce the observed protection. It was concluded that about a third of the excess isomerization of CPB in the blend can be accounted for in terms of energy transfer to the vinylene groups from excited vinyl and methylene groups in PE which otherwise would give rise to vinyl decay and hydrogen evolution. The

remaining two-thirds of the energy transfer is believed to involve other excited or ionized states which would, in the absence of CPB, not normally result in hydrogen production. (M.C.G.)

22228 THE RADIATION-INDUCED OXIDATION OF 4-t-BUTYLPYROCATECHOL IN AQUEOUS SOLUTIONS. George W. Black and Benon H. J. Bielski (Brookhaven National Lab., Upton, N. Y.). J. Phys. Chem., 66: 1203-4 (June 1962). (BNL-5828)

When 4-t-butylpyrocatechol was irradiated with Co^{60} gamma rays in air-saturated 0.8N H_2SO_4, it was oxidized to the corresponding 4-t-butyl-o-quinone. An investigation for other organic products gave negative results. It was found that the G-values for the appearance of 4-t-butyl-o-quinone and H_2O_2 were independent of total dose, dose rate, and initial concentration above 5.0×10^{-3} mole/l. (M.C.G.)

22229 VARIATION WITH TEMPERATURE OF THE HYPERFINE SPECTRUM OF POLYCRYSTALLINE POWDERS OF GLYCOCOLL IRRADIATED WITH γ RAYS. André Bottreau and Serge Nahon (Laboratoire d'Optique Ultrahertzienne, Faculte des Sciences, Bordeaux, France). J. phys. radium, 23: 131-2(Feb. 1962). (In French)

A systematic study was made of the spectra of polycrystalline powders of glycocol as a function of temperature in order to define the region of hyperfine structure change. The apparatus used was described in detail. The samples received integrated doses of 4,000,000 r, and a quintet structure was observed from room temperature to -80°C. The three central components fuse to give a plateau. This plateau then becomes hollow in the vicinity of -110°C to give a quartet which could be followed to -170°C. (J.S.R.)

22230 PREPARATION OF S^{35}-LABELED SULFATES. M. Kucharski, A. Pasternak, and R. Plejewski (Inst. of Nuclear Physics, Polish Academy of Sciences, Warsaw). Kernenergie, 5: 171-2(Mar. 1962). (In German)

A method for the preparation of labeled sodium and potassium sulfate by utilizing ion exchange resins was developed. Carrier-free $H_2S^{35}O_4$ was used as the starting compound. This method can also be used for the preparation of other sulfates and bisulfates soluble in water. (tr-auth)

22231 THE EFFECTS OF IRRADIATION ON POLYPROPYLENE. Hiroshi Sobue and Yoshio Tajima. Kôbunshi, 9: 907-13(Oct. 1960).

Discussions are given on the effect of irradiation on crosslinking and chain scission of polypropylene, the effect of irradiation temperature, the behavior of chain scission and endlinking in the initial period of the irradiation process, as well as oxidation and graft copolymerization by irradiation, and electron-spin-resonance absorption of irradiated polypropylene. (OID)

22232 ELECTRIC CONDUCTIVITY OF IRRADIATED HIGH POLYMERS. Eiichi Fukada. Kôbunshi, 9: 999-1003(Nov. 1960).

When polyethylene was irradiated, the electric conductivity was increased during irradiation and gradually decreased after the irradiation. The induced electric conductivity of polyethylene by irradiation increased with increasing temperature and increasing radiation dose. The electron theory of the irradiation conductivity of high polymers and the distribution of electron traps are discussed. In the low dosage range, no permanent change in the induced conductivity occurred, but in the high dosage range some degree of irreversible chemical change occurred in the polymer, so that the max. conductivity was observed several hours after the irradiation. When polyethylene was irradiated, crosslinking increased. The electric conductivity was at a max. when the material being irradiated became rubber-like; then, the conductivity gradually decreased while the polyethylene became a glass-like material with increasing dosage. (OID)

22233 THE EFFECTS OF VARIOUS MEDIA ON THE IRRADIATION OF POLYMERS. Zenichiro Kuri. Kôbunshi, 9: 950-52(Nov. 1961).

Electron-spin-resonance spectrum analysis showed that the irradiation of polyethylene in a vacuum produced $-CH_2-\dot{C}H-CH_2-$ radicals, while irradiation in air produced peroxide radicals. When polyvinyl chloride powder (PVC) was irradiated in a vacuum and, then, such radical scavengers as H_2S, NO, NO_2, Br_2, and O_2 were introduced, radical patterns disappeared, and the radicals did not react with gases, such as SO_2, H_2, NH_3. When PVC powder was irradiated in H_2S, NO, NO_2, and Br_2 gas, no radical was formed. When teflon was irradiated in a vacuum, the ESR spectra were very complicated, and when O_2 was introduced into the system peroxide-type radicals were formed. Free radicals generated from irradiated polyvinyl alcohol did not react with NO, NO_2, H_2S, Cl_2, H_2, NH_3, SO_2, and O_2 when irradiation was carried out in a vacuum or in the presence of the gases mentioned. (OID)

22234 RADIATION EFFECTS ON HIGH POLYMERS AND THE EFFECTS OF WATER. Akibumi Danno. Kôbunshi, 10: 526-30(June 1961).

The radiation polymerization of an aqueous solution of acrylonitrile is discussed. When an aqueous solution of polymer having a concentration of less than 0.5g/100 cc was irradiated, the viscosity of the solution decreased and the disintegration of polymer molecules became significant. For a concentration greater than 1g/100 cc, the degree of crosslinking among solute molecules and the viscosity of the solution increased. After further irradiation, the solution goes into the gel state. For a concentrated aqueous solution of polymethacrylic acid, the viscosity of the solution decreased and the irradiation caused molecular decomposition. In a concentrated polyvinyl alcohol (or polyvinylpyrrolidone) solution, the radiation energy absorbed by water was transformed into the energy required for binding polyvinyl alcohol molecules. The maximum grafting efficiency of polyvinyl alcohol film with methyl methacrylate (MMA) was obtained by irradiation in the solution in a 20 : 80 : 15 ratio of MMA : methanol : H_2O. (OID)

22235 ELECTRON-SPIN-RESONANCE ABSORPTION OF IRRADIATED HIGH POLYMERS. Shunichi Ônishi, Yûichi Ideda, and Isamu Nitta. Kôbunshi, 10: 615-23(July 1961).

Discussions are included on (1) studies of free radicals of irradiated polymers by ESR spectrum analysis, (2) quantitative analysis of free radicals, (3) kinetic analysis of free-radical yields, (4) tracking of free radical reactions in polymers, (5) the effects of the state of aggregation of polymer molecules, and (6) ESR spectrum analysis. (OID)

22236 CHEMICAL STUDIES ON THE EFFECT OF RADIATION ON POLYVINYL ALCOHOL. I. THE END GROUPS FORMED BY THE γ-IRRADIATION OF WATER-SWOLLEN POLYVINYL ALCOHOL. Ichiro Sakurada and Syuzi Matsuzawa. Kobunshi Kagaku, 17: 268-72(Apr. 1960).

Samples of PVA films, which were water-swollen 2.5 ~ 3 times, were irradiated in air and at room temperature at doses up to 1.9×10^6 to 1.2×10^7 r from a Co^{60} source. No gel formation was observed, but the main chain scission was predominant. The G-value of scission was 6.7. The carbonyl and carboxyl groups were formed by scission and increased with increasing dose forming a 2 : 1 ratio

at the 1.2×10^7 r level. These groups constitute between 60 and 90% of the total end groups formed by scission. Oxygen in air and water played important roles in these radiation effects. (OID)

22237 THE EFFECT OF γ-RAYS ON POTATO STARCH. (ENGLISH TEXT). A. Mishina and Z. Nikuni (Usaka Univ.). Mem. Inst. Sci. and Ind. Research, Osaka Univ., 17: 216-18(1960).

Air-dried potato starch granules containing 18.5% moisture were irradiated from a source of 1,400 C. Co^{60} with doses of 10^5-10^8 r. After irradiation, the intrinsic viscosity and viscoelasticity, measured with a V.I. viscometer, and the blue value of the starch specimens decreased, while the reducing sugar value, alkali lability number, carboxyl value and carbonyl number of the specimens increased with the radiation dose. X-ray diffraction diagrams showed that the crystalline part of the potato starch was damaged after doses of up to 1.5×10^7 r. From the highly irradiated product of potato starch granules, D-glucose, maltose, arabinose, D-gluconic acid, D-glucuronic acid and a series of small dextrins were identified by paper chromatography. These mono- and oligo-saccharides were analyzed by anion exchange column chromatography, and D-glucose and maltose were shown to be the main fission products. Gases in the products of starch granules were also analyzed chromatographically after γ-irradiation and hydrogen, carbon mono- and di-oxide were identified. These results indicated that hydrolysis and oxidation of starch specimens occur during irradiation. Therefore, potato starch is considered, like cellulose, as a γ-ray degradation type polymer under these conditions. (auth)

22238 THE E.S.R. SPECTRUM OF IRRADIATED AMMONIUM HYPOPHOSPHITE. J. R. Morton (National Physical Lab., Teddington, Middx., Eng.). Mol. Phys., 5: 217-23(May 1962).

Electron spin resonance spectra of irradiated crystals of ammonium hypophosphite $(NH_4)^+(H_2PO_2)^-$ indicated that the ionic radical $H\dot{P}O_2^-$ is initially formed. The hyperfine interaction tensor of the phosphorus nucleus had the principal values 1698, 1228, and 1228 Mc/s. Interaction with the proton gave rise to an almost isotropic hyperfine coupling of 230 Mc/s. These results indicated that the species $H\dot{P}O_2^-$ is irregular tetrahedral in shape, the unpaired electron occupying a hybrid σ orbital centered on the phosphorus nucleus. There was evidence that the radical $H\dot{P}O_2^-$ reacts with an adjacent $H_2PO_2^-$ ion forming the species $O_2\dot{P}-PHO_2^-$. The principal values of the hyperfine interaction tensors of the two phosphorus nuclei were 1365, 944, 921 Mc/s and 527, 362, 359 Mc/s, respectively. The proton had an isotropic hyperfine coupling of 90 Mc/s. The spectra of irradiated deuterated crystals confirmed this analysis. (auth)

22239 THE TRANSFORMATION OF THYMINE-2-C^{14} BY X RADIATION IN VITRO AND IN VIVO. E. R. Lochmann and G. Riebke (Freien Universität, Berlin). Naturwissenschaften, 49: 158(1962). (In German)

Radioactive thymine with a specific activity of 9.5 mC/mmole was suspended in various media under almost equal conditions of x irradiation. The degree of transformation was determined as a function of the mass of radioactive urea arising in the destruction of the thymine. The results obtained are tabulated. (J.S.R.)

22240 POLAROGRAPHIC STUDIES ON THE STORAGE OF MEATS. PART VI. THE INFLUENCE OF γ-IRRADIATION ON BEEF IN POLYETHYLENE BAGS. Tetsujiro Obara and Yasokichi Ogasawara. Nippon Nôgei-kagaku Kaishi, 34: 208-14(Mar. 1960).

Beef samples were vacuum-packed in 3.5×10^{-2} mm thick polyethylene and irradiated with a 250-c Co^{60} source at a dosage ranging from 70.3×10^4 to 259×10^4 r. The odor, color, Walkiewicz reaction, pH, water content, and quantities of protein in aqueous and salt water extracts are related to the radiation dosage. Paper chromatograms of free amino acids and organic acids from a nonirradiated sample and a sample irradiated at 70.3×10^4 r were about the same; however, chromatograms differed markedly for the samples irradiated at 259×10^4 r in which free creatine and creatinine disappeared. For the samples irradiated at less than 259×10^4 r, no change in height and shape of protein wave was detected. (OID)

22241 POLAROGRAPHIC STUDIES ON THE STORAGE OF MEAT. PART VII. THE INFLUENCE OF γ-IRRADIATION ON BEEF IN POLYETHYLENE BAGS. Tetsujiro Obara and Yasokichi Ogasawara. Nippon Nôgei-kagaku Kaishi, 34: 319-23(Apr. 1960).

γ-Irradiated beef was vacuum-packed in polyethylene and stored at 20°C for 57 days. The irradiation increased the storage life but irradiated samples wrapped with thin polyethylene sheet could not be stored for a long period at room temperature. With increasing dosage, a definite change was noted in the height of the crossing point of the protein wave of the irradiated samples after storage for 57 days. The crossing points obtained from protein waves of various NH_4OH concentrations in aqueous and 7% NaCl extract solutions were about the same and independent of the dosage. Significant differences were noted in the protein contents of samples with and without irradiation. However, differences in the protein contents in aqueous and 7% NaCl extract solutions of the samples irradiated at different dosages were not significant. (OID)

22242 POLAROGRAPHIC STUDIES ON THE STORAGE OF MEAT. PART VIII. THE INFLUENCE OF γ-IRRADIATION ON THE SHELF LIFE, COLOR, AND PROTEIN CONTENT OF BEEF. Tetsujiro Obara and Yasokichi Ogasawara. Nippon Nôgei-kagaku Kaishi, 34: 323-8(Apr. 1960).

The irradiated samples had a long storage life, and samples in polyethylene bags could be stored for a long period at room temperature. As the dosage increased the odor became stronger; however, the odor diminished as the storage period increased. As the dosage increased, the color of meat changed to a bright mild red color. If the wrapping is secure, the color remains the same throughout the storage period. With an increasing dosage, the change in adsorption in the 450–700 mμ range by chromoprotein in the aqueous extract solution of irradiated beef after shelf period decreased. The amount of protein in an aqueous extract solution remained in the neighborhood of 2% throughout the 52 days–storage at 20°C. (OID)

22243 POLAROGRAPHIC STUDIES ON THE STORAGE OF MEAT. PART IX. THE INFLUENCE OF γ-IRRADIATION ON ORGANIC ACIDS AND FREE AMINO ACIDS OF BEEF. Tetsujiro Obara and Yasokichi Ogasawara. Nippon Nôgei-kagaku Kaishi, 34: 397-403(May 1960).

The amount of lactic acid in the irradiated beef increased with increasing dosage, then decreased after 240×10^4 r. The amount of free creatinine and creatine decreased with increasing dosage. No change in the free amino acid content was noticed with varying dosage. The lactic acid content of samples irradiated with 200×10^4 r tended to increase after 21 days of storage at 20°C. With increasing dosages, the creatine content was decreased with increasing shelf period. The free amino acid content increased somewhat with increasing dosage. (OID)

22244 POLAROGRAPHIC STUDIES ON THE STORAGE OF MEAT. PART X. THE INFLUENCE OF γ-IRRADIA-

TION ON THE PROTEIN WAVE OF BEEF. Tetsujiro Obara and Yasokichi Ogasawara. Nippon Nôgei-kagaku Kaishi, 34: 795-800(Oct. 1960).

The heights, shapes, and crossing points of protein waves from aqueous and 7% NaCl extracts of samples immediately after irradiation were similar to those of nonirradiated samples at various dosage levels. As the shelf period at 20°C increased, a distinctive change was seen in the shape and crossing point of the protein wave of the aqueous extract solution; i.e., the height of the no. 2 wave became greater than that of the no. 1 wave, and the crossing point was indistinguishable. This indicated a significant change in the characteristics of protein in the aqueous extract solution. The shape and crossing point of the protein wave of the 7% NaCl extract solution showed little change. (OID)

22245 THE EFFECT OF γ-IRRADIATION ON AMYLOSE IN A SOLID STATE. A. Nishimura (Otani Women's Junior Coll., Japan). Nippon Nogei Kagaku Kaishi, 35: 510-16(1961).

Amylose was irradiated in a solid state from a Co^{60} source, receiving a total dose of 10^5-10^8 r. The intrinsic viscosity and blue value of the iodine complex of the amylose specimens decreased, while the reducing sugar value increased. These results indicate that γ-irradiated amylose molecules are degraded. Moreover, the carboxyl value and the ultraviolet and infrared absorption spectra showed that amylose molecules were oxidized by γ-irradiation. There was a difference between γ-irradiated starch and amylose in their β-amylolysis limit: the β-amylolysis limit of γ-irradiated amylose with crystalline sweet potato β-amylase was greatly decreased, while it has been reported that the β-amylolysis limit of starch is increased by γ-irradiation. The β-amylolysis limit of γ-irradiated amylose with bacterial crystalline α-amylase decreased similar to β-amylase. Moreover, the amylolysis limit of the γ-irradiated amylose with saccharogenic amylases (Rh. Delemar type and Asp. niger type) was low as compared with the original amylose. This is considered to be the reason for the decrease of the amylolysis limit of the amylose specimens and shows that any structural change produced in the glucose chains by γ-irradiation inhibits the action of the enzymes. (auth)

22246 INORGANIC PRECIPITATION OF CARBON IN PRODUCTIVITY EXPERIMENTS UTILIZING CARBON-14. Charles R. Goldman and David T. Mason (Univ. of California, Davis). Science, 136: 1049-50(June 22, 1962).

Fe was added to natural waters, and photosynthesis was measured by the radiocarbon method. Inorganic precipitation of C^{14}, presumably by mechanisms of occlusive coprecipitation, resulted from additions of 100 or more micrograms of Fe per liter. Low levels of Fe and prefiltered controls are suggested as correction measures. (auth)

22247 CHEMICAL EFFECTS OF RADIOACTIVE DECAY. Wilhelm Forsling (Forskningsinstitutet för fysik, Kärnkemiska Avdelningen, Stockholm). Svensk Kem. Tidskr., 74: 201-8(1962). (In Swedish)

A short survey is given of some chemical effects obtained from different types of radioactive decay. In spontaneous nuclear reactions the recoiling atoms often possess energies far exceeding the chemical bond energies. This fact is sometimes used in nuclear chemistry for the separation of nuclides especially in the heavy element region. Recoil methods are also widely applied in the study of fission products and for the labeling or organic compounds. (auth)

22248 EFFECT OF RADIATION ON CERTAIN CHARACTERISTICS OF ELECTROLUMINESCENT SCREENS. L. M. Boiko. Ukrain. Fiz. Zhur., 6: 866-9(1961). (In Russian)

Electroluminescent screens were investigated with simultaneous electro- and photo-excitation. The frequency dependence had a maximum at 12 to 13 kcps, on the position of which various forms of radiation, ultraviolet, x and gamma radiation, have no effect. The brightness of the luminescent screen in an alternating electric field decreased during irradiation with ultraviolet light and increased during x irradiation, the effect depending on the frequency. The possibility of obtaining "images" on the electroluminescent screen was verified. (auth)

22249 ON X-RAY DAMAGE AND ITS INFLUENCE ON THE SPECTRAL DISTRIBUTION OF THE PHOTOCURRENT IN CdS SINGLE CRYSTALS. K. W. Boeer, E.-H. Weber, and B. Wojtowicz (Humboldt Universität, Berlin and Physikalisch-Technische Institut, Berlin). Z. Physik, 168: 115-28(1962). (In German)

The influence of a preceding x-ray irradiation (60 to 200 kev) at the spectral distribution of the photocurrent of "pure" CdS monocrystals is investigated by irradiation with polarized light parallel or perpendicular to the c-axis and at room temperature as well as at −176°C. (auth)

22250 MEASUREMENTS OF ACTIVITY OF TRITIUM CONTAINING ORGANIC COMPOUNDS. A. N. Nesmeyanov, V. V. Pozdeev, and Ya. Klass (Moscow State Univ.). Zavodskaya Lab., 28: 305-7(1962). (In Russian)

The activity of tritium labeled mixtures containing 50% CH_4 and H_2 was measured with Geiger-Mueller counters using cyclohexane gas. The organic compound was burned at 640°C in the presence of Zn, NiO, and H_2O. (R.V.J.)

22251 THE USE OF ^{14}C FOR THE STUDY OF MASS TRANSFER. T. B. Copestake and F. S. Feates (Atomic Energy Research Establishment, Harwell, Berks, Eng.). IAEA Preprint CN-13/32. 17p. (In English)

To be published in the Proceedings of the IAEA Conference on the Corrosion of Reactor Materials held in Salzburg, 4-9 June 1962.

In a graphite-moderated, carbon dioxide-cooled reactor, the extent of graphite oxidation is necessarily small, and the use of conventional methods for corrosion studies (e.g., weight loss or gasification) is difficult. Accelerated corrosion experiments are rarely practicable since there are limited sources of radiation more intense than those found in a reactor and those which are available have radiation spectra very different from reactor radiation. Consequently, C^{14} tracer techniques were developed as sensitive methods of following the interchange of carbon between the solid and the gas phase. C^{14} was incorporated into graphite in a variety of ways. Attempts were made to label selectively either the internal pores or the external surface as well as the whole graphite uniformily. A range of graphites were prepared ranging from high-density pyrolytic graphite to low-density compacts. The properties of the various materials are discussed. Gasification of these materials was studied by measuring the C^{14} activity appearing in the gas phase and scintillation counting techniques are described which permit rapid routine analysis of the radiolytic products. Autoradiographic methods show the irreversible adsorption of CO^{14} onto graphite surfaces. The distribution of carbonaceous deposits from irradiated CO^{14}/CO_2^{14} mixtures was examined by sectioning and combustion of the graphite specimens. Further applications of the C^{14} technique are suggested. (auth)

22252 THERMAL ANNEALING OF CHEMICAL RADIATION DAMAGE IN IONIC CRYSTALS FOLLOWING (n,γ) AND I. T. ACTIVATION. K. Heine, G. B. Schmidt, and

W. Herr (Cologne Universitilt and Max-Planck-Institut für Chemie, Mainz). IAEA Preprint SM-25/2. 15p. (In English)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials held in Venice, Italy, 7-11 May 1962.

In ionic crystals, chemical and radiation fragments are produced by (n,γ) and isomeric transition activation, which can be detected by simple chemical analysis. These metastable fragments in the solid show a distinct annealing behavior at various temperatures. It is of interest to follow the kinetics of these processes, because they reflect the behavior of isolated defects in the case of low radiation damage. Investigations were made in some detail by conventional chemical precipitation and paper electrophoresis on the reactions of these recoil defects in crystalline hexahalogene- and pentaminebromo-complexes of the platinum elements. In solid-state physics several models have been developed to explain the annealing of lattice vacancies and interstitials. But these simplifying models do not describe sufficiently the annealing of recoil fragments in ionic crystals. For instance in $Na_2IrCl_6 \cdot 6H_2O$, several different recoil fragments were observed, whose individual annealing behavior indicates a superposition of physical and chemical processes. These results show that chemical aspects are also important to explain radiation damage in ionic crystals. (auth)

Raw Materials and Feed Materials

22253 (ACCO-3) PROGRESS REPORT [ON URANIUM EXTRACTION FROM ORES], MARCH 16, 1951–MAY 15, 1951. (American Cyanamid Co. Atomic Energy Div., Watertown, Mass.). Contract AT(49-1)-533. 45p.

Investigations dealing with ores from Grants, New Mexico, the Lukachukai Mountain District in Arizona, the Belgian Congo, the Thomas Mountain Range in Utah, and the Witwatersrand, South Africa were made. Anionic exchange resin studies such as resin in pulp, self-elution with Rand leach liquors, adsorption of uranyl nitrate and uranyl perchlorate, adsorption of Fe, Mn, Co, As, and Mo from sulfate solutions, and adsorption of U from chloride bearing sulfate solutions are reported. Results are given of a study of the sulfating step in the lyometallurgy process. (auth)

22254 (ACCO-7) PRELIMINARY REPORT ON RECOVERY OF URANIUM FROM LOW GRADE BELGIAN CONGO ORES. Topical Report. J. J. Brunner, D. R. George, and E. M. Rubino (American Cyanamid Co. Atomic Energy Div., Watertown, Mass.). Oct. 5, 1951. Contract AT(49-1)-533. 33p.

Leaching investigations on low grade Belgian Congo uranium ores and recovery of uranium from acid leach solutions by uranous phosphate precipitation, uranyl phosphate precipitation, and by sodium carbonate retreatment of alkali precipitates are described. (auth)

22255 (ACCO-9) PRELIMINARY REPORT ON RECOVERY OF URANIUM FROM HIGH CARBONATE BELGIAN CONGO URANIUM ORES. Topical Report. D. R. George, R. H. Kennedy, E. M. Rubino, and F. A. Howland (American Cyanamid Co. Atomic Energy Div., Watertown, Mass.). Oct. 30, 1951. Contract AT(49-1)-533. 20p.

Optimum conditions for leaching uranium ore samples with H_2SO_4 and the recovery of uranium from the leach solutions as a product containing at least 40% U_3O_8 are given. Precipitation of U by addition of orthophosphoric acid, following reduction of the pregnant solutions with thin Al shavings, yielded precipitates of uranous phosphate, which after leaching with NaOH to remove phosphate and unreacted Al, and drying at 110°C, contained 53 to 64% U_3O_8. Recovery from solution was 96 to 99%. (P.C.H.)

22256 (ACCO-10) APPLICATION OF HEAVY MEDIA SEPARATION, FLOTATION AND CARBONATE LEACHING TO CONGO ORES. Topical Report. John B. Breymann, III. (American Cyanamid Co. Atomic Energy Div., Watertown, Mass.). Oct. 31, 1951. Contract AT(49-1)-533. 62p.

The possibility of separating the U minerals from the carbonate minerals in magnesitic-dolomitic U ores from Union Minière du Haute Katanga, Belgian Congo, by heavy media separation or froth flotation was investigated. Tables are included which show conditions and reagents. Results of tests of carbonate leaching of the whole ore and of the carbonate flotation products are also tabulated. (auth)

22257 (ACCO-11) RECOVERY OF URANIUM FROM CONGO LEACH LIQUORS WITH ION EXCHANGE RESINS. Topical Report. Richard H. Kennedy and Frederick A. Howland (American Cyanamid Co. Atomic Energy Div., Watertown, Mass.). Oct. 31, 1951. Contract AT(49-1)-533. 24p.

A method is described for recovering uranium from sulfuric acid leach liquors of Congo ores using anion exchange resins. Excellent uranium recoveries were obtained in cyclic tests which indicate uranium capacities of 11 to 26 lbs of U_3O_8 per cubic foot of resin per day. Preliminary tests indicate that sulfuric acid may be as effective as hydrochloric acid in providing the required acidity in the eluant. (auth)

22258 (ACCO-18) PRELIMINARY LEACHING INVESTIGATION OF ORES FROM RADIUM HILL, SOUTH AUSTRALIA. Topical Report. R. F. Hollis, J. B. Breymann, and J. T. Lynch (American Cyanamid Co. Atomic Energy Div., Watertown, Mass.). June 30, 1952. Contract AT(49-1)-533. 43p.

Leaching tests on uranium ores from Radium Hill, South Australia, indicated high recoveries could be obtained by using large quantities of H_2SO_4 and boiling for relatively long periods. Filtration rates were satisfactory, but large settling areas are required to wash and thicken before filtering. (auth)

22259 (ACCO-20) PROGRESS REPORT [ON PROCESSING URANIUM ORES], JANUARY 16, 1952–MARCH 15, 1952. (American Cyanamid Co. Atomic Energy Div., Watertown, Mass.). Contract AT(49-1)-533. 98p.

Analytical development and production results of laboratory and field work on problems connected with U ore processing and concentration are reviewed. Froth-flotation test work on Congo ores yielded results of interest. Field test work with an ion-exchange column pilot plant gave encouraging results with respect to recovery and grade of product. Continued work is reported on the proper flowsheet for V recovery from U ores. Ion-exchange tests on U leach liquors were satisfactory. Flowsheets and cost estimates for Mn recovery from Rand barren leach liquors were completed. Filtration rate studies on leached pulps derived from samples from the Rand district are reported. The effect of polythionates and Co on U adsorption of Rand acid leach liquors was studied. The technique of using batch adsorption and column elution for evaluating the life of a resin was investigated. A small pilot plant unit for resin-in-pulp operation in which baskets made of stainless steel screen were used to hold the resin beads while pulp is passed through the apparatus was constructed and tried

out. Evaluation work on a number of samples of new resin types was started. Test work on the effect of KMn04 in Na carbonate leaching and on the U_3O_8 extraction from U ores is reported. Lyometallurgical tests and liquid-liquid extraction tests on nitric acid leach liquors from Radium Hill ores using both hexone and ether are reported. (auth)

22260 (ACCO-21) PRELIMINARY LEACHING INVESTIGATION OF BABROSCO AND AFRIKANDER LEASE RESIDUES. Topical Report. R. F. Hollis and J. T. Lynch (American Cyanamid Co. Atomic Energy Div., Watertown, Mass.). May 12, 1952. Contract AT(49-1)-533. 11p.

Leaching and filtration tests were conducted on dump samples and current residues from Afrikander Lease and Babrosco properties on the Witwatersrand, South Africa. Tests showed that optimum recovery under the conditions investigated involved a 16 hr leach at 60% solids with 63.2 lb of H_2SO_4 and 18 to 20 lb of MnO_2 per ton of ore. Filter tests on 2 samples marked Slime Dam Composite and Current Residues indicated that 595 and 1110 lb of ore, respectively, could be filtered per ft^2 of filter area in 24 hr. The filter rate could be increased to 1280 and 1745 pounds per ft^2 per day by adding 0.2 pounds of carboxy methyl cellulose per ton of ore. (P.C.H.)

22261 (ACCO-22) RECOVERY OF URANIUM BY ION EXCHANGE OR BY URANOUS PHOSPHATE PRECIPITATION FROM SULFURIC ACID LEACH SOLUTIONS PRODUCED FROM AUSTRALIAN DAVIDITE ORE CONCENTRATES. Topical Report. D'Arcy R. George (American Cyanamid Co. Atomic Energy Div., Watertown, Mass.). June 9, 1952. Contract AT(49-1)-533. 22p.

Uranium ore from Radium Hill, South Australia was leached with hot sulfuric acid solutions and the uranium recovered from solution by uranous phosphate precipitation or by use of anion exchange resins. 94 to 98% of the uranium was recovered at a grade of 52 to 65% U_3O_8 by uranous phosphate precipitation. (auth)

22262 (ACCO-23) RECOVERY OF MANGANESE DIOXIDE FROM RAND BARREN SOLUTIONS. Topical Report. Albert W. Owens (American Cyanamid Co. Atomic Energy Div. Raw Materials Development Lab., Winchester, Mass.). Mar. 15, 1953. Contract AT(49-1)-533. 44p.

In the disposal of the barren liquors from the uranium recovery plants on the Witwatersrand it is proposed that any manganese present be recovered as MnO_2 and be used as oxidant in the acid leaching circuit. The Fe^{3+}, Al, and Si are first removed by neutralizing to pH 4.5 with limestone and filtering. The filtrate is raised to pH 9.3 with a lime slurry and the $Mn(OH)_2$ filtered off. The $Mn(OH)_2$ is repulped with lime water and raised to pH 12.0 with lime slurry after which it is aerated 5 to 6 hours at that pH. The MnO_2 is filtered and dried before using. (auth)

22263 (ACCO-34) REMOVAL OF CHLORIDE FROM CONGO PRECIPITATES. Topical Report. Hans I. Viklund and Richard H. Kennedy (American Cyanamid Co. Atomic Energy Div. Raw Materials Development Lab., Winchester, Mass.). Nov. 3, 1953. Contract AT(49-1)-533. 29p.

Uranium precipitates obtained from Congo leach liquors by an ion exchange process contained more than 0.1% chloride. Attempts were made to reduce the chloride content of typical precipitates by calcination of dried precipitate, releaching of dried precipitate with water, and washing of wet precipitate with water. Washing of wet precipitate with an aqueous solution of 0.25% Na_2SO_4, to prevent peptization, provided a simple solution to the problem. Precipitation tests on Congo ion exchange eluates showed a marked advantage in subsequent thickening and filtration operations for precipitation from hot solution. (auth)

22264 (ACCO-41) UTEX LEACHING, THICKENING AND FILTRATION TESTS. Topical Report. Alan Stanley, D'Arcy R. George, Peter N. Thomas, Robert A. Eisenhauer, James T. Lynch, and Stanley E. Richardson (American Cyanamid Co. Atomic Energy Div. Raw Materials Development Lab., Winchester, Mass.). Mar. 15, 1954. Contract AT(49-1)-533. 79p.

A series of leaching, thickening, and filtration tests was undertaken to determine minimum conditions for high uranium extractions and obtain thickening and filtration data. The ore represented by the sample responded to cold and hot leaching with the minimum condition for uranium extraction being 500 pounds of H_2SO_4 per ton and five pounds $NaClO_3$ per ton leached at room temperature for 16 hours with uranium extraction of over 95%. Thickening and filtration were economical if a reagent such as S-3000 or Guar gum was used. (auth)

Separation Processes

22265 (AERE-CE/M-190) THE SOLUBILITY OF THORIUM NITRATE IN TRIBUTYL PHOSPHATE AND THE PREPARATION OF THE DISOLVATE COMPLEX. PART III. W. H. Hardwick, P. Swift, and R. Todd (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Nov. 13, 1956. 14p.

The analyses of some saturated solutions of thorium nitrate in TBP at various temperatures for water are reported. The white precipitates thrown down on cooling by some of the solutions were found to be hydrated thorium nitrate. The maximum solubility of thorium nitrate in TBP at 103°C was obtained by equilibrating TBP with a solid hydrate of composition $Th(NO_3)_{3.65}(OH)_{0.35} \times H_2O$, where x is about 6. (auth)

22266 (HW-58068) APPLICATION OF PYROCHEMICAL PROCESSING DEVELOPMENTS TO THE URANIUM-233–ALUMINUM FUEL ELEMENT PROGRAM. W. L. Lyon, R. H. Moore, and E. E. Voiland (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 29, 1958. Contract AT(45-1)-1350. 9p.

The purification of U^{233}-Al alloy fuel material from hazardous U^{232} daughter activities may be accomplished by contacting the molten alloy with a salt mixture of potassium and aluminum chlorides. Th^{228} is preferentially extracted into this salt phase, thus breaking the decay chain, while the bulk of the uranium remains in the metal phase. The same salt phase can be re-used a number of times, possibly more than 5, to process fresh alloy samples before the residual thorium reaches an unacceptably high level. Prior to discard of the salt flux, the residual U^{233} can be readily removed by several contactings with pure aluminum. (auth)

22267 (HW-71583) MINERAL ADSORPTION OF PHOSPHORUS-32 FROM REACTOR COOLANT. D. W. Bensen (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 1962. Contract At (45-1)-1350. 17p.

P^{32} adsorption from 80°C tap water by 21 minerals was determined. Eleven of the minerals adsorbed 30% or more of the influent P^{32}. Mixed mineral columns were better adsorbents than single mineral columns. The best mineral mixtures (i.e., pyrite-Florida pebble phosphate-calcite and pyrite-Idaho rock phosphate-calcite) absorbed 65 to 70% of the influent P^{32}; whereas, the best adsorption

by single minerals (i.e., sodalite, epidote, goethite, fluorite, pyrite, and pyrrhotite) ranged from 37 to 60%. A limited number of experiments indicated that adsorption of P^{32} from actual reactor coolant may be lower than those reported. (auth)

22268 (IDO-14564) AN EVALUATION OF FOUR PROCESSES FOR RECOVERING URANIUM FROM ZIRCONIUM FUELS AT THE IDAHO CHEMICAL PROCESSING PLANT. P. Burn (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Apr. 27, 1962. Contract AT(10-1)-205. 62p.

Four zirconium fuel processes—the present STR process, the modified Zirflex process, the barium fluorzirconate process, and the sodium formate process—were evaluated in detail for technical and economic feasibility. The evaluation was based on installation as the second generation Idaho Chemical Processing Plant zirconium process. Two nonaqueous processes, the ARCO and the fused salt fluoride volatility processes, were included in a preliminary evaluation, but were eliminated on the basis that major problems inherent in the processes are not yet solved. A continuous version of the STR process was concluded to be the leading contender for immediate plant application. (auth)

22269 (TID-15919) FOAM SEPARATION. Quarterly Progress Report No. 5, October 1, 1961 to December 31, 1961. H. M. Schoen, E. Rubin, E. Schonfeld, and R. Everett, Jr. (Radiation Applications Inc., Long Island City, N. Y.). Feb. 27, 1962. For Oak Ridge National Lab., Tenn. Contract [W-7405-eng-26], Sub-contract 2024. 37p.

Additional studies on the effect of pH and Ca^{++} concentration on separation of Sr^{++} and Cs^{+} were conducted. Studies on the effect of Na^{+} concentration were initiated. The experimental results on the effect of pH and Ca^{++} concentration confirmed the general conclusions arrived at earlier. Na^{+} had a negative effect on the separation of Sr^{++} and Cs^{+}. The distribution factor of these metal ions started to drop rapidly when Na^{+} concentration was between 10^{-4} and 10^{-3}M. Various procedures in treating simulated ORNL low-level waste with NaOH, prior to foam separation, were attempted. The experimental results indicated that pretreatment at pH 11.5 rather than 10.5 results in good separation of Sr^{++}. The studies included effect of pH adjustment and filtration, effect of pH adjustment without filtration and effect of pH adjustment with NaOH and readjustment with HNO_3. Very good separation of Sr^{++} was obtained in experiments with a 6" diameter continuous foam separation column. (auth)

22270 SEPARATION OF RUTHENIUM FROM BASE METALS BY CATION EXCHANGE. H. Zachariasen and F. E. Beamish (Univ. of Toronto). Anal. Chem., 34: 964-6 (July 1962).

A method for the separation of ruthenium from large amounts of associated base metals in dilute hydrochloric acid solution by cation exchange resin is described. The method was also applied for the determination of ruthenium in a copper-nickel-iron assay button. (auth)

22271 SEPARATION OF URANIUM FROM FISSION PRODUCTS USING CELLULOSE. Noboru Oi (Tokyo Shibaura Electric Co., Ltd.). Bull. Chem. Soc. Japan, 35: 214-18(Feb. 1962). (In English)

The separation of uranium from fission products using cellulose was demonstrated. Uranyl nitrate hexahydrate containing fission products was dissolved in an organic solvent that had low solubility of water, and this solution was passed through the column of cellulose. Almost all of the fission products were retained on the cellulose, while uranium passed almost unadsorbed. The most labile nuclides were found to be ruthenium and cesium. Free nitric acid had to be eliminated to prevent the elution of ruthenium. It was found that the adsorption of fission products decreased with the increase in the uranium concentration of the organic solvent. Therefore the concentration of uranium that passed through the column was limited to below 0.2M. It was also found that water is necessary. (auth)

22272 STUDIES ON SOLVENT EXTRACTION USING RADIOACTIVE ISOTOPES. VIII. SOLVENT EXTRACTION OF CERIUM WITH ACETYLACETONE. Nobuo Suzuki and Shohachiro Oki (Tohoku Univ., Sendai). Bull. Chem. Soc. Japan, 35: 233-6(Feb. 1962). (In English)

The extraction of cerium with acetylacetone was studied using Ce^{144} as a tracer. Cerous ions could not be extracted without an oxidizing agent. After the mixture of 0.61M acetylacetone, 0.65M sodium bromate, and 5×10^{-4}M cerium was left standing for 100 min at pH 5 to 6, 95% of the cerium was extracted in benzene. The reaction was accelerated by heating or by increasing the concentration of acetylacetone and bromate. The presence of phosphate, oxalic acid, citric acid, tartaric acid, and EDTA caused severe interference. (auth)

22273 STUDIES ON SOLVENT EXTRACTION USING RADIOACTIVE ISOTOPES. IX. SOLVENT EXTRACTION OF CARRIER-FREE CERIUM-144 WITH ACETYLACETONE. Nobuo Suzuki and Shohachiro Oki (Tohoku Univ., Sendai). Bull. Chem. Soc. Japan, 35: 237-9(Feb. 1962). (In English)

Ce^{144} was extracted with acetylacetone in a benzene or in a carbon tetrachloride solution by shaking for 3 min at a pH range of 4 to 9. Though an oxidizing agent such as bromate was not always necessary, the presence of bromate made the time for extraction shorter. Decontamination of other fission products and rare earths, except $Zr^{95}(Nb^{95})$ was found to be negligible. The contamination of $Zr^{95}(Nb^{95})$ was reduced to a negligible amount by repeating the cycle of extraction and stripping or by masking Ce^{144} with thiocyanate. The separation of Ce^{144} from Pr^{144} was attempted. Pr^{144} with a radiochemical purity of more than 99% was easily obtained by washing the organic phase with an acetate buffer solution of pH 5 to 8. (auth)

22274 A SYSTEMATIC ION EXCHANGE SEPARATION OF METALLIC ELEMENTS. I. GROUP SEPARATION OF METALLIC ELEMENTS BY ANION EXCHANGE WITH HYDROCHLORIC ACID. Jun Yoshimura and Hirohiko Waki (Kyushu Univ., Fukuoka). Bull. Chem. Soc. Japan, 35: 416-19(Mar. 1962). (In English)

As the first stage in the systematic separation of metallic elements by ion exchange, a group separation on an ordinary scale was tried using an anion exchanger "Dowex 1-X8" with HCl, a method based on Kraus' method. Most metallic elements usually treated in the chemical analysis can be separated into 4 groups by the elution through a 40 ml column using 11, 6.5, and 3M HCl as elutriant. Satisfactory results were obtained on analysis for a mixed solution. These classifications may be explained in terms of the formation of a chloro-complex of a metal, not only in solution phase but also in resin phase. (auth)

22275 NOTE ON THE SOLVENT EXTRACTION OF SOME METALS BY TRI-N-OCTYL PHOSPHINE OXIDE. Hideo Saisho (Mitsubishi Atomic Power Industries, Inc., Saitama-ken, Japan). Bull. Chem. Soc. Japan, 35: 514-15 (Mar. 1962). (In English)

The extraction behavior of Zr, Hf, Nb, and Ta in the system of tri-n-octyl phosphine oxide (TOPO)-cyclohexane

and HCl or HNO_3 was investigated. The distribution ratio, determined by tracer studies, when plotted versus logarithmic TOPO concentration, showed a constant slope of about 2 in all cases. (M.C.G.)

22276 SEPARATION OF FRANCIUM BY PAPER ELECTROPHORESIS. Jean-Pierre Adloff and Roger Bertrand (Centre de Recherches Nucléaires, Strasbourg). Compt. rend., 254: 2575-7(Apr. 2, 1962). (In French)

Paper electrophoresis in a high electric field (80 v/cm) allows the separation of Fr from Ac in equilibrium with all its derivatives in less than 1 min. The electrolyte, the ammonium salt of an organic acid, complexes all the elements present with the exception of Fr. (tr-auth)

22277 THE MECHANISM OF THE EXTRACTION OF SEVERAL PROTON ACIDS BY TRI-n-BUTYL PHOSPHATE. Keiji Naito and Toshio Suzuki (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Chem., 66: 983-8(June 1962).

The distribution equilibria of several proton acids (HNO_3, HCl, $HClO_4$, HOAc, H_2SO_4, $H_2C_2O_4$, and H_3PO_4) between aqueous and TBP phases were measured. The mechanism of extraction of these acids was confirmed as a reaction between acid ions and TBP molecules, and the formation of the complexes, $HNO_3 \cdot TBP$, $HNO_3(TBP)_2$, $HCl \cdot TBP$, $HCl(TBP)_3$, $HClO_4$-$(TBP)_3$, $HOAc \cdot TBP$, and $H_2C_2O_4(TBP)_2$, was confirmed. The order among the extractabilities of these acids suggests that the extractability may be correlated with the hydration energy of the anion. (auth)

22278 THE MECHANISM OF THE EXTRACTION OF SEVERAL URANYL SALTS BY TRI-n-BUTYL PHOSPHATE. Keiji Naito and Toshio Suzuki (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Chem., 66: 989-95 (June 1962).

The extraction of several uranyl salts (nitrate, chloride, perchlorate, sulfate, acetate, and phosphate) by TBP was studied. The formation of the complexes $UO_2(NO_3)_2(TBP)_2$, $UO_2Cl_2(TBP)_2$, $UO_2(OAc)_2(TBP)_2$, and $UO_2(ClO_4)_2(TBP)_4$ was confirmed by partition study and infrared study. The influence of acid concentration on uranium extraction was discussed, especially for the system $UO_2(ClO_4)_2$–$HClO_4$–TBP. The order of the extractabilities of the uranyl salts was compared with that of the acids. (auth)

22279 THE REMOVAL OF RADIOSTRONTIUM FROM MILK. REPORT OF A UNITED STATES PILOT PLANT PROCESS. L. F. Edmondson, H. E. Walter, A. M. Sadler, F. P. Hanrahan, D. G. Easterly, et al. Milk Ind., 50: 64, 66, 68(1962).

The operation of a pilot plant (100 gal. milk/hr) designed for the removal of Sr^{90} from milk by ion exchange treatment is described. The process, which will remove about 90% of the Sr^{90} in milk, involves the steps of charging the resin bed, acidifying the milk to pH 5.3 to 5.4 with citric acid, filtering the milk through a column of cationic ion exchange resin (of the nuclear sulphonic acid type), neutralizing the milk to a normal pH with dilute KOH, cleaning and sanitizing the resin, and finally regenerating the resin. Work is in progress to lower the costs of the process by reducing the quantities of salt used for regenerating the resin. (Pub. Health Eng. Abstr.)

ENGINEERING AND EQUIPMENT

General and Miscellaneous

22280 (AD-269388) ELECTRIC PROPULSION SYSTEMS. Appendix 1. B. D. Bedford and G. W. Kessler (General Electric Co. General Engineering Lab., Schenectady, N. Y.). Oct. 1961. Contract NONR-3485(00). 24p.

Electric motor systems for submarine propulsion are studied with respect to maintenance, noise, size, reliability, and efficiency. The types studied include d-c, a-c, and acyclic motor systems. Schematic diagrams are presented of various systems. The advantages and disadvantages of each system show that a turbo-acyclic drive has the most over-all potential. (N.W.R.)

22281 (AD-269394) HYDRAULIC TORQUE CONVERTER. Appendix 7. F. M. MacDonald and J. Bendersky (General Electric Co. General Engineering Lab., Schenectady, N. Y.). June 1961. Contract NONR-3485(00). 40p.

The use of the torque converter principle in marine propulsion transmission was investigated. This included scaling an existing design by laws of similitude (with two unit compounding for high speed ratio), torque converter compounded with gearing, and single unit torque converter design with axial flow components for high speed ratio. No existing single unit torque converter design will meet the reduction ratio requirements of 15 or 25 to 1 at practical efficiency levels. To meet required speed ratio, it is necessary to compound two units of existing design, compound one torque converter unit with single gear reduction, and design a new torque converter unit with pump and turbine elements adapted to high speed ratio. High speed ratio torque converter designs involve high flow, low head, and high relative flow velocities, leading to high fluid friction losses and tendency to cavitate. (auth)

22282 (AD-269395) LOW MAINTENANCE MACHINERY FOR SUBMARINE POWER PLANTS. APPENDIX 8. HYDROKINETIC TRANSMISSION. D. W. Craft (General Electric Co. General Engineering Lab., Schenectady, N. Y.). Aug. 1961. Contract NONR 3485(00). 72p.

Methods of varying the power output of a hydrokinetic transmission at constant speed input with minimum loss in efficiency and obtaining astern power by the use of thrust reversers in the propeller system were investigated. The torque converter transmission with a variable geometry pump rotor is the most satisfactory transmission for obtaining power control with constant input speed from the point of view of efficiency. This type of transmission requires some innovations for providing reliable methods for attachment and adjustment of the pump rotor blades. Thrust reversers in the propeller stream have the greatest promise for a reliable method of producing reversing power. (auth)

22283 (AD-269400) APPRAISAL OF VARIOUS MECHANICAL TRANSMISSIONS. Appendix 13. H. Stern (General Electric Co. General Engineering Lab., Schenectady, N. Y.). Oct. 1961. Contract NONR-3485(00). 25p.

An appraisal is made of various mechanical means of transforming thermal power into hydraulic power, i.e., steam energy into ship thrust. The steam motor direct drive for a propeller makes a very attractive transmission. It is being explored in detail under a separate phase of the program. The torque converter development could result in substantially improved propulsion systems with either turbine or reciprocating steam prime movers. Other mechanical transmission schemes which were investigated include: hydraulic split transmissions using both hydrokinetic and hydrostatic elements; belt drives; and variable pitch propellers. Hydrodynamic shear drives are being evaluated separately. Of the transmission currently thought feasible, the Fottinger transformer and the steam motor direct-drive offer the greatest incentive for further investigation. (auth)

22284 (AD-269423) A FEASIBILITY STUDY OF A MAGNETO-HYDRODYNAMIC CENTRIFUGE (thesis). Luin Blunt Ricks (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio). Aug. 1961. 59p. (GE/EE/61-15)

A study was made of the magnetohydrodynamic centrifuge, a d-c motor with a mercury armature. Centrifuging action is derived from the rotating mercury which, at sufficient speeds, assumes the shape of a hollow ring. A development prototype is designed and tested to determine the feasibility of such a centrifuge. Results were promising and indicated that the basic operational principle is sound and feasible. A paddle wheel was rotated at 2000 rpm by a rotating ring of mercury at an estimated mercury input power of 5 watts. (auth)

22285 (DC-59-6-19) NON-AXISYMMETRICALLY LOADED CYLINDER EXPERIMENTAL CHECKOUT. W. E. Nickola (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). May 27, 1959. Contract AT(11-1)-171. 58p.

A thin-walled aluminum cylinder (OD 12.35 in., wall thickness 0.093 in., length 12.00 in.) was subjected to two non-axisymmetrical radial loads and two non-axisymmetrical moment loads. The loads were applied adjacent to one end of the cylinder through two rectangular loading areas or tabs which were positioned at diametrically opposite locations. The loading tabs were $\frac{1}{8} \times 1\frac{1}{2}$ in. and were oriented such that the $1\frac{1}{2}$ in. dimension was parallel to the longitudinal axis of the cylinder. One hundred and eighty-nine strain gages were bonded to the cylinder and strain measurements were made during both the radial and moment loading conditions. Circumferential and axial stresses were calculated from the experimental strain measurements. Cylinder deflections were also measured while under load. (auth)

22286 (MSAR-61-99) STUDY OF ENERGY CONVERSION DEVICES. Report No. 7. Final Report, July 1959–May 1961. T. A. Ciarlariello, J. B. McDonough, and R. E. Shearer (MSA Research Corp., Callery, Penna.). Sept. 14, 1961. Contract DA-36-039-SC-78955. 74p. (AD-270212).

Prior experiments showed the feasibility of alkali and alkaline earth metal/molten salt electrolyte/hydrogen gas electrochemical cells. These cells produce metal hydride, heat and electric power. Batch regeneration of a calcium–hydrogen cell was demonstrated. Regenerative cells were tested. The major difficulties noted were the plugging of the circulating salt lines, the low dissociation pressure of LiH in dilute solutions, and an electric cell-shorting effect arising after long operation. Various molten salt electrolytes were tested. Low melting point eutectic salts containing Na, Rb, Cs, K, and Li were found. Fluorides, bromides, and chlorides were found to be the best electrolytes.

Borohydrides and iodides were not satisfactory. Various hydrogen electrode materials were tested. The best electrodes consisted of mesh electrodes or sintered porous disks. The dissociation of LiH over molten salts was determined, and the LiH content of various cell electrolytes was measured. The feasibility of the electrochemical cell, and of the hydride dissociation was demonstrated. However, the complete regenerative system was not reduced to practice. (auth)

22287 (TID-15789) COMPOSITE CHARACTERISTIC OF TWO TUNNEL DIODES IN SERIES (thesis). Felix A. Spies (Kansas. Univ., Lawrence). May 1962. Contract [AT(29-1)-613]. 67p.

The composite voltage-current characteristic of two tunnel diodes in series was first examined by construction and then by experiment. Composite negative conductance regions were emphasized and a method of varying the composite negative conductance was demonstrated. Several photographs of experimental composite characteristics showed that the construction technique will predict details of the composite negative conductance regions. Two series tunnel diodes in a switching mode were then analyzed qualitatively by singular point analysis. The four stable equilibrium points were then verified experimentally. (auth)

22288 (WAPD-T-1473) CONTROL ENGINEERING APPLICATIONS OF V. I. ZUBOV'S CONSTRUCTION PROCEDURE FOR LYAPUNOV FUNCTIONS. S. G. Margolis and W. G. Vogt (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Jan. 25, 1962. Contract AT-11-1-GEN-14. 24p.

Presented at the Joint Automatic Control Conference, June 1962, New York City, New York.

The determination of a stability domain of a control system, the motion of which is described by nonlinear differential equations, by a method for obtaining a solution to this problem proposed recently by the Russian mathematician, V. I. Zubov, is discussed. The fundamental principles of V. I. Zubov's procedure for constructing Lyapunov functions for nonlinear systems are outlined. If the construction problem can be solved, it leads to a Lyapunov function which uniquely defines the exact boundary of the stability region. For the application of the method, several simple examples are treated in which the exact stability region is found in analytic closed form. Since the construction procedure requires the solution of a linear partial differential equation, there are many cases for which an exact analytic solution is not possible. In some of these cases, however, it is possible to construct an approximate series solution which is always at least as good as the usual quadratic form Lyapunov function. The series construction procedure was programmed (In IBM 7070 FORTRAN language) for a broad class of differential equations of the second order. A simple example solved by the digital computer program is described. (auth)

22289 THE DYNAMIC RESPONSE OF SHALLOW-BURIED ARCHES SUBJECTED TO BLAST LOADING. Caryll Robbins Whipple (Univ. of Illinois, Urbana). Dissertation Abstr., 22: 2735(Feb. 1962).

A study was made of the effectiveness of the surrounding soil in restraining the lateral movement of shallow-buried arches subjected to blast overpressures from a nuclear explosion. The arches were considered to be buried near the surface of a semi-infinite soil mass. The term "shallow-buried" is used to refer to a configuration and amount of earth cover such that reflected and dynamic pressures are not effective in loading the arch and yet not so great as to provide significant free-field attenuation of air-blast-induced overpressures in the soil. Depths of cover over the crown exceeding one-half of the arch span were not considered. This restricted the location of the arch to a region adjacent to the earth's surface in which there appeared to be no measurable attenuation of free-field overpressures in the soil and in which the restraint offered to soil movement by the blast overpressure acting on the ground surface was significant. The approach used led to conservative results for deeper burial. A theory was developed for the expression of the combined resistance of the arch and the soil to dynamic loads. In writing the equations of motion the deformation resistance of the arch was expressed in terms of the capacity of the arch rib cross section while the deformation resistance of the soil was expressed using classical earth pressure theory to define the states of stress developed in the soil surrounding the arch as the arch-soil "structure" responds. The inertial resistance of the arch was related to the mass of the arch while the inertial resistance of the soil was related to that portion of the surrounding soil mass which may logically be assumed to move with the arch during response to a blast load. The theory was developed for parabolic arches with circular arches included as a special case. The arch may have any distribution of mass and thickness. The dynamic analysis was simplified by replacing the actual soil and arch system which is continuous and has an infinite number of degrees of freedom by a discrete framework consisting of a series of rigid bars, flexible joints and point masses. Both elastic and inelastic deformations were permitted. The equations of motion were solved using a step-by-step method of numerical integration. The problem was programmed for solution on the ILLIAC, the high-speed digital computer at the University of Illinois. A series of numerical solutions is presented for varying combinations of arch geometry and material, depth of earth cover, overpressure loading, seismic velocity in the soil, and ratio of horizontal to vertical overpressure induced in the soil by the shock wave in air. The effects of the various parameters are noted and discussed. It was concluded that well compacted soil surrounding a shallow-buried, underground arch contributes the major portion of the resistance of the arch-soil "structure" to lateral deformation under the blast loading resulting from a nuclear explosion.

22290 A PUSH-UP TYPE Co^{60} IRRADIATION FACILITY. T. Mochizuki and E. Tsuda. Genshiryoku Kôgyô, 7: No. 4, 18-20(Apr. 1961).

The 500-c Co^{60} source was enclosed in a stainless steel-plated Pb cylinder with outside dia. of 60 mm and 780 mm high. The effective thickness of the Pb cylinder shield is 260 mm. For safety measure, a mechanical interlocking system and a monitor alarm system are provided. The dose rate is about 10^5 r/hr near the source. The entire irradiation facility is an underground installation. The source is raised by a reversible motor at a rate of 600 mm/min. An eccentric rotation disc-type shutter is provided at the top of the source cylinder. The shutter speed is 180°/min. The door between the irradiation room and the control room is equipped with a magnetic key and a key switch. The system is interlocked so that the source does not move unless the door is locked. The guide tube for the source has an outside dia. of 40 mm. In case of a malfunction in the servomechanism for the source, the source will return automatically to the storage point. The leakage is below 0.6 to 1.2 mr/hr. (OIE)

22291 COMPARATIVE INVESTIGATION OF DIFFERENT GAS TURBINE PROCESSES FOR NUCLEAR ENERGY

PLANTS. W. Fratzscher and P. Koenig. Kernenergie, 5: 143-53(Mar. 1962). (In German)

The application range of the cycle proposed by Gante was extended to the comparative study of different cycles. This was successful since given constant exterior conditions were used for the operation of gas turbine processes in nuclear energy plants. The maximum temperature, the maximum pressure, and the maximum heat load are significant, and these were used as the constant selected values. With this method it is possible to compare the utility of various processes with each other. The significance of the comparison lies within the pedagogic range. The present investigation can serve as the basis for the evaluation of heat engineering precautions for the improvement of individual processes, especially when economic considerations must be taken into account. (tr-auth)

22292 CESIUM-137 GAMMA-RAY UNIT. Hisaji Fukatsu. Toshiba Rev. (Japan), No. 6, 37-43(1961).

For applications involving 2,000- to 3,000-c radiation units for long and medium distance use, and 200- to 300-c radiation units for short distance use, this instrument, which was designed mainly for therapeutic uses, can be adapted for other uses also. Cs^{137} does not require replacement of the radiation source as does Co^{60}, and the shielding of the equipment and the building is much simpler than with Co^{60}. (OID)

22293 A RELEASE-WIRE TYPE RADIOISOTOPE RADIOGRAPHIC DEVICE. Sumio Makino, Masaaki Kashiwazaki, and Tadaichi Tsuzuki. Toshiba Rev. (Japan), 16: 571-3(May 1961).

The release-wire type radioisotope radiographic system consists of a source container, a source-transfer tube, a control system, and a cart. The Pb-shielded, cast-iron framed maze-type source container has no shutter system. A key switch is provided to prevent the movement of the source when the apparatus is moved about. The source consists of 1 mm dia. × 1 mm long Co^{60} pellets in double SUS-33-type capsules. The source travels in the flexible tube and can be manipulated manually or by a motor-driven mechanism. The system is designed for maximum health protection. (OID)

22294 A NEUTRONS SOURCE GENERATOR. Kiyomi Nishibori. Toshiba Rev. (Japan), 16: 1167-74(Sept. 1961).

A description is given of the first neutron source generator constructed in Japan. This generator has a maximum accelerating voltage of 200 kv, a full load of 1 ma, and an output of 10^{10} n/sec or over when a Harwell tritium–titanium target is used. The (α/n), (γ/n) reactions including $Na^{24}-D_2O$, $Na^{24}-Be$, Ra–Be, and $Sb^{124}-Be$, and artificial neutron sources are listed. (OID)

22295 JOURNAL BEARINGS. Stanley Whitley (to United Kingdom Atomic Energy Authority). U. S. Patent 3,039,830. June 19, 1962.

A hydrostatic gas journal bearing is designed which has a load capacity in excess of that provided by an externally pressurized orifice compensated journal bearing of equivalent size and power. The bearing has at least three portions in sequence along the bearing, the first being an externally pressurized orifice compensated journal bearing portion, the second being a circumferential groove with means for controlling the pressure in the groove, and the third being a journal bearing portion with means for applying pressure which is circumferentially asymmetric. Another circumferential groove and another externally pressurized orifice compensated journal bearing portion may also be used as fourth and fifth portions of the bearing, respectively. (D.L.C.)

Heat Transfer and Fluid Flow

22296 (CUA-NE-20) SIMULATED NUCLEAR REACTOR VIBRATIONAL HEAT TRANSFER. Quarterly Progress Report, August 1, 1961–October 31, 1961. (Catholic Univ. of America, Washington, D. C.). Contract AT(30-1)-2655. 8p.

Testing was initiated in the pool heating testing program with piezoelectric ceramic transducers providing ultrasonic vibrations in the water. Evaluation of data led to an examination of the heater which showed a lack of uniformity of temperature over its surface. A heater was designed employing ribbon-type nichrome wire instead of Glas-Col elements. A program was conducted to eliminate the electrical ground loops from the test area. The program of pool heating with mechanical vibrations produced by the electrodynamic shaker was continued. (M.C.G.)

22297 (DC-61-1-22) INVESTIGATION OF THE EFFECTIVE THERMAL CONDUCTIVITIES FOR A FINNED COOLANT TUBE LITHIUM HYDRIDE SPECIMEN. D. J. McKee (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Jan. 3, 1961. Contract AT(11-1)-171. 13p.

The effective thermal conductivity of cast lithium hydride was evaluated as a function of temperature as influenced by nonhomogeneous (cracked) distribution, various gases in voids, finned surfaces, thermal cycling, and partial adhesion to container. It was found that the over-all effective conductivity of lithium hydride and its container can be raised to 6.1 and 3.0 Btu/hr-ft-°F at 250 and 900°F, respectively by using finned surfaces and helium. The use of finned surfaces alone will raise the over-all effective conductivity to 3.3 and 2.6 Btu/hr-ft-°F at 250 and 900°F, respectively. (P.C.H.)

22298 (DC-61-2-76) A COMPARISON OF MIXED AND STRATIFIED REVERSE FOLDED FLOWS. J. F. Heyda (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Feb. 1961. Contract [AT(11-1)-171]. 9p.

The one-dimensional approach for studying reverse folded flows through a porous resistance was compared with the two-dimensional model, emphasis being placed on balanced flows. The flow described by the one-dimensional model requires instantaneous mixing in the outlet header whereas that described by the two-dimensional approach is stratified. For uniform flow through the resistance mixed and stratified flows yield static pressure distributions which are identical, apart from a constant factor, whenever outlet header wall shapes are of the form x^n, $(0 \leq n < 1)$. Inlet and outlet header wall shapes are simply related for the one-dimensional model by readily manageable analytical expressions whereas the two-dimensional model requires the evaluation of singular integrals. (auth)

22299 (DC-61-6-9) A FOLDED FLOW SENSITIVITY STUDY. ANP Program No. 334. J. A. Delaney (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). May 31, 1961. Contract [AT(11-1)-171]. 61p.

The ANP computer program No. 334, a folded flow sensitivity study, which is an extension to more general configurations of the program from which the results of a flow sensitivity study of a balanced reverse folded flow, were obtained is presented. (auth)

22300 (DP-698) PRESSURE DROP FOR FLOW OF BOILING WATER AT HIGH PRESSURE. Nicholas Dinos (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). May 1962. Contract AT(07-2)-1. 22p.

Pressure drops were measured for the upward flow of

boiling water inside a heated tube that mocked up a coolant channel of a power reactor fuel assembly. The tube was 18 feet long and ½ inch in diameter; the test conditions included system pressures between 400 and 1000 psia, mass velocities from 0.8×10^6 to 7.9×10^6 lb/(hr)(ft^2), inlet subcoolings from 29 to 96°C, and exit vapor qualities up to 50%. For certain conditions, the flow was a multiple-valued function of the pressure drop. The measured pressure drops were an average of 7% higher than values calculated on the assumption that the two-phase mixture was a single phase with averaged properties. (auth)

22301 (K-1528) SIFT — AN IBM-7090 CODE FOR COMPUTING HEAT DISTRIBUTIONS. David Bagwell (Oak Ridge Gaseous Diffusion Plant, Tenn.). July 6, 1962. Contract W-7405-Eng-26. 120p.

A program named SIFT was written for the IBM-7090 extending the usefulness and convenience of the TOSS program. This code contains an input generator which greatly reduces the labor involved in setting up data for input to the code. The SIFT program will solve the heat transfer equations for the transient and/or steady state temperature distribution of a three dimensional irregular body using a first forward difference method. Given the geometrical and physical description of the assembly, it will give as output the temperature distribution as a function of time. (auth)

22302 (SCTM-335-61(71)) THE COMPRESSIBLE LAMINAR BOUNDARY LAYER WITH ARBITRARY HEAT TRANSFER AND PRESSURE GRADIENT. P. E. Lambdin (Sandia Corp., Albuquerque, N. Mex.). Nov. 1961. Contract [AT(29-1)-789]. 16p.

An approximate method of calculating the laminar, compressible boundary layer for two-dimensional bodies and axially symmetric bodies of revolution with arbitrary pressure gradient, Mach number, and wall temperature is presented. No knowledge of the boundary layer velocity or temperature profiles is required. (auth)

22303 (TID-15920) THE EFFECT OF SURFACE TENSION ON BOILING HEAT TRANSFER (thesis). John Bernard Roll (Purdue Univ., Lafayette, Ind.). Aug. 1962. 184p.

The static and dynamic surface tension were measured for aqueous solutions of eleven surface active agents for the purpose of studying the effect of surface tension upon boiling heat transfer. The surfactants were chosen from the Tween, Aerosol, and Hyonic series. The phenomenon of dynamic or nonequilibrium surface tension arises because of the finite time required for a surfactant molecule to become oriented at an interface. It is demonstrated by the existence of an apparent surface tension somewhere between the value for pure solvent and the static or equilibrium value. Dynamic surface tension was investigated by observing the volume and frequency for air bubbles forming from a submerged orifice. In all cases, the dynamic surface tension for solutions of these surface active agents was less than the value for pure water, greater than the static value for the same concentration, and was a smoothly decreasing function of concentration. The static values were measured using a duNouy tensiometer. Values were recorded at temperatures approaching T = 100°C; the value at this temperature was obtained by extrapolation. Results show that the static surface tension at 100°C may have a positive or negative value for $d\sigma/dT$ depending upon the solute-concentration combination chosen. Further, it was shown that although in general the static surface tension decreases with increases in concentration, there are instances where static surface tension increases with increases in concentration. The heat transfer data were taken in three groups. The first group of data was used to construct plots of the steady-state heat transfer coefficient versus the superheat. The Tween series showed results which could be interpreted quite successfully on the basis of a decrease in the critical radius for nucleation. The Hyonic series resulted in a fouling of the surface, perhaps due to some decomposition of polymerization product. The Aerosol series showed a cleansing action which kept the surface free of fouling and may even have increased the micro-roughness such that the heat transfer coefficient increased. The second group of data was obtained by observing the immediate temperature response upon addition of a surface active agent. In this way the time-related surface effects described above were eliminated. Analysis of these data indicated that the value of the surface tension which gave the best correlation with the liquid superheat was an arithmetic average of the static and dynamic values. Calculations based upon mass transfer to the growing bubble demonstrated why this was so. The final group of data was obtained using high speed photography. In this manner, quantities such as bubble volume, delay time, and growth time could be measured for the various solutions. A model is presented to describe the manner in which surface tension changes these variables. Results from this model show that surface tension is effective because it changes the nucleating properties of the liquid and not because it alters its hydrodynamic character. Results obtained using this model, as well as data from the films, show that the previously accepted concept of the significance of the balance between buoyancy and surface tension forces at bubble "break-off" is in error. The three sets of data all tend to confirm the hypothesis that surface tension is a factor in boiling heat transfer only because it affects the nucleating properties of the liquid. Hydrodynamic effects, such as bubble volume and frequency, are the direct results of the nucleation effects and are not themselves changed significantly by the surface tension. (auth)

22304 (TID-15975) TWO-PHASE FLOW THROUGH AN APERTURE (thesis). George R. Gavalas (Minnesota, Univ., Minneapolis). May 1962. Contract AT(11-1)-926. 76p.

In the outflow of saturated water through a two-dimensional opening, the amount of vapor formed within the flashing fluid as the pressure drops is unknown. Use may be made of the analyses for the incompressible ideal flow in the case of no vaporization. For the other extreme of equilibrium between the liquid and vapor phases, a method was developed to treat the two-phase mixture as a compressible fluid, and with the help of the Hodograph Transformation specific results are presented. Finally, a growing bubble model was developed to approximate mixtures which exhibit an incomplete approach to equilibrium. (auth)

22305 (UCRL-6807) FLUID MECHANICS AND HEAT TRANSFER FOR GASES (AIR, He, H_2, AND N_2) FLOWING SINGLE PHASE IN CLOSED CHANNELS. A Bibliography. Rose Kraft (California, Univ., Livermore, Lawrence Radiation Lab.). Feb. 21, 1962. Contract W-7405-Eng-48. 31p.

References (284) are given to reports and U. S. and foreign journals published from April 1946 to 1961. The arrangement of the references is alphabetical by author. (P.C.H.)

22306 (FTD-TT-62-111) HEAT TRANSFER FROM A GRANULAR LAYER TO A TUBE WALL IN THE PRESENCE

OF INTERNAL HEAT SOURCES. V. A. Rastaturin. Translated from Izvest. Vysshikh Ucheb. Zavedenii, Khim. i Khim. Tekhnol., No. 1, 138-41(1961). 6p.

By interpretation of the equation of thermal conductivity for solids with internal heat sources, it was found that the particular coefficient of heat transfer from a granular layer to a tube wall is equal to the doubled effective thermal conductivity of the granular layer divided by the inside radius of the tube. The equation in contrast to all other equations is the most efficient. (auth)

22307 (JPRS-13610) PROFILING OF THE THERMAL LOADING ALONG A REACTOR CHANNEL WITH CONSIDERATION OF THE NONUNIFORMITIES OF HEATING OF THE HEAT TRANSFER AGENT. N. N. Ponomarev-Stepnoi (Ponomarov-Stepnoy). Translated from Inzhener.-Fiz. Zhur., Akad. Nauk Belorus. S.S.S.R., 5: No. 2, 42-6 (Feb. 1962). 9p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 16, abstract no. 16511.

22308 (NP-tr-896) UNIFORM FLUIDISATION OF SPHERICAL PARTICLES. Jan Beña. Translated by L. H. Sinclair (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.) from Chem. průmysl, 8: 516-23(1958). 30p.

Fluid-dynamic relationships governing the flow of liquids in a uniformly fluidized layer of spherical particles are established. An entirely new general correlation is introduced for the fluidized state. (auth)

22309 STUDY OF THE CONVECTIVE HEAT TRANSFER OF A GRAPHITE-IN-GAS SUSPENSION DURING INTERNAL FLOW THROUGH VERTICAL CANALS. Z. R. Gorbis and R. A. Bakhtiozin. Atomnaya Energ., 12: 378-84 (May 1962). (In Russian)

A gas containing suspended graphite dust particles may represent a novel coolant with superior heat transfer characteristics for gas-cooled reactors. The complex heat transfer process taking place between the heated surface and the two-phase system of gas and solid particle is little known at present; for this reason a study was made of the convective heat transfer in cylindrical canals in which a gaseous graphite suspension was circulated. An approximate hydrodynamic formula was derived on the basis of the following assumptions: (1) the boundary layer is fixed; (b) there is no slippage between the solid and gaseous phases; (c) the velocity and temperature regions are similar, and (d) the hydraulic losses and the mass and heat transfer data are additive. Devices consisting of various Cu pipes were used for the experimental verification of the formulas derived; they made it possible to vary the Reynolds number of the flowing system within a wide range. The tests consisted in comparing the heat transfer characteristics of the system while either pure air or air containing graphite particles was flowing through the heated pipes. It was found that with increasing Reynolds number the relative heat transfer decreases. Using CO_2, He, or other gases the Prandtl number must be also considered. Comparative tests with graphite, aluminosilicate, and quartz showed that the nature of the particle dose not affect the heat transfer characteristics of the system as the specific weights and heat capacities of these materials are nearly identical. (TTT)

22310 AVERAGE AND LOCAL HEAT TRANSFER FOR CROSSFLOW OF LIQUID METAL IN A TUBE BANK. Corwin Lloyd Rickard (Cornell Univ., Ithaca, N. Y.). Dissertation Abstr., 22: 2742(Feb. 1962).

Local and average heat transfer coefficients were obtained for the flow of mercury normal to a staggered tube bank. The tube bank consisted of sixty ½-inch tubes, six wide and ten deep, arranged in an equilateral triangular array. Results are presented showing the effects of Reynolds number, Prandtl number, wetting of the tube surfaces by the mercury, gas entrained in the liquid metal flow, tube location in the bank, and angular variation of tube surface temperature on the local and average heat transfer coefficients. Circumferential heat flow in the wall of the tubes is shown to have an important bearing on calculation of "true" local heat transfer coefficients. Analytical studies of heat transfer to liquid metals in a tube bank are presented which show the theory to be only in fair agreement with the experimental results. Pressure drop results for both mercury and water flow through the tube bank are also given. The range of Reynolds numbers and Prandtl numbers covered in the mercury heat transfer tests was 20,000 to 200,000 and 0.014 to 0.022, respectively. A check on the accuracy of the experimental technique by measuring heat transfer rates to water flowing through the tube bank covered the Reynolds number range 8,000 to 20,000. The principal results obtained from the study are: the average and local heat transfer coefficients for a tube with approximately constant surface temperature located in the interior of the tube bank can be expressed by the equations $Nu = 4.03 + 0.228\ (Pe)^{0.67}$ and $Nu(\theta) = [4.11 + 0.29(Pe)^{0.67}][1.21 + 1.04 \cos \theta]^{1/3}$ respectively; the average heat transfer coefficients at a given Reynolds number are higher for constant surface heat flux conditions than for constant surface temperature conditions; gas entrained in a liquid metal flow reduces heat transfer coefficients only under conditions of non-wetting and wetting or non-wetting of the heat transfer surfaces has no effect on the coefficients in the absence of gas entrainment and surface fouling; friction factors measured for the flow of mercury through the tube bank under non-wetting conditions are in general agreement with those for ordinary fluids and wetting or non-wetting of the tube surfaces in a tube bank has little if any effect on the pressure loss; and analytical solutions for heat transfer to liquid metals in a tube bank which are based on assumptions of molecular conduction and potential flow give Nusselt numbers which are 25% to 39% below the experimental results at a Peclet number of 4,000 and 8% to 18% below at a Peclet number of 600.

22311 EFFECT OF GEOMETRIC SHAPE AND CONVECTIVE HEAT TRANSFER ON THE PERFORMANCE OF A THERMOELEMENT. Charles N. Rollinger (Northwestern Univ., Evanston, Ill.). Dissertation Abstr., 22: 2743(Feb. 1962).

The effects of variable cross-sectional area and surface heat transfer on the optimum performance of a thermoelement were investigated. The surface heat transfer, which takes place along the longitudinal surface of the thermoelement, was assumed to occur by the process of convection. Separate analyses were made of insulated thermoelements with arbitrary cross-sectional area, convectively cooled, cylindrical thermoelements, and convectively cooled, shaped thermoelements. The analysis of insulated, shaped thermoelements indicated that these elements offer no advantage over insulated elements with constant cross-sectional area. The results showed that insulated elements with constant cross-sectional area make more efficient use of material than insulated, shaped elements. The study of a convectively cooled, cylindrical thermoelement used as a Peltier heat pump indicated that convective cooling of the surface of the element, which heretofore was considered a loss, can be used to advantage if the system is properly designed. It was found that the

maximum temperature difference, the maximum heat pumped, and the maximum coefficient of performance could be increased through the use of this heat transfer mechanism. Gains in performance were increased as the convective heat transfer coefficient increases. The results showed that part of the element near the cold junction must always be insulated in order to increase the optimum performance. The expressions presented can be used to determine the optimum length to be insulated. The investigation of a convectively cooled, cylindrical thermoelement used as a power generator showed that convective cooling always increases the maximum power output and in many situations it increases both the maximum power output and the efficiency. Gains in the maximum power output were found to increase as the convective heat transfer coefficient is increased. Maximum power output always occurred with the entire element convectively cooled, but the highest thermal efficiency was achieved with some part of the element near the hot junction insulated. The study of convectively cooled, shaped thermoelements resulted in analytical expressions for the temperature distribution and maximum heat pumped. These results can be used to determine the performance of convectively cooled thermoelements of various practical shapes.

22312 FORCED CONVECTION SUBCOOLED NUCLEATE BOILING HEAT TRANSFER INSIDE AN ELECTRICALLY HEATED TUBE OF SMALL DIAMETER AND LARGE L/D RATIO. Paul Wei-ming Ing, (Univ. of Wisconsin, Madison). Dissertation Abstr., 22: 3971(May 1962).

A literature survey was made on boiling. This includes bulk boiling, natural and forced convection boiling, two-phase flows, pressure drops, and the stability phenomena. Experiments were performed with special emphasis on the forced convection subcooled nucleate boiling heat transfer inside an electrically heated tube of small diameter and large L/D ratio. Instrumentation was provided to measure temperatures, variations of temperatures, pressures, pressure differentials, mass flow rates, and flow observations. Test results showed the effect of pressure, of inlet subcooling, and of mass velocity on heat transfer. Effects of heat flux on tube wall and fluid temperatures were also observed, particularly in relation to temperature waves and flow stability. Heat transfer correlations were obtained for both the non-boiling and the subcooled nucleate boiling inside the test section.

22313 PARTICLE–LIQUID COCURRENT DOWNWARD FLOW THROUGH A TUBE WITH A RESTRICTING ORIFICE END FOR APPLICATION TO A MOBILE FUEL NUCLEAR REACTOR SYSTEM. Wan Yong Chon, Evan C. Kovacic, and Frederick G. Hammitt (Atomic Power Development Associates, Inc., Detroit). Nuclear Sci. and Eng., 13: 65-74 (June 1962).

Cocurrent downward flow of a settled bed of particles in a liquid medium through a straight tube with a restricting orifice at the lower end was studied in connection with a "paste" type mobile fuel system developed for a fast breeder reactor. It was found that the excess liquid flow rate around the particles, and other related physical quantities, could be satisfactorily evaluated through moving-bed correlations. In order to determine the absolute, rather than excess or relative, flow rates of both liquid and particles, a correlation was needed by which the flow through the restricting orifice of the system could be coupled with the flow in the straight tube section above the orifice. Correlations using two dimensionless quantities, i.e., effluent paste density expressed as the ratio of particle flow rate to total flow rate, and an "in-orifice" modified Reynolds' number, were developed for both wetted orifices (i.e., paste discharging through an orifice into a liquid phase) and nonwetted orifices (paste discharging through an orifice into a gaseous phase). Square-edge orifices were employed as well as tapered edge orifices. The ranges of the principal variables covered experimentally were as follows: particle size, 60 to 325 mesh (1.7 to 9.8 mils); particle density, 2.6 to 18.9 g/cm^3; liquid viscosity, 0.004 to 0.2 cm^2/sec; particle flow rate, 5 to 40 cm^3/min; and orifice diameter, 0.075 to 0.199 in. (auth)

22314 SIMULATION OF THE THERMAL PROCESSES IN THE REACTOR CORE BASED ON AN EXACT SOLUTION OF THE THERMAL DIFFUSION AND HEAT FLOW EQUATIONS. W. Ciechanowicz (Inst. of Nuclear Research, Warsaw). Nuclear Sci. and Eng., 13: 75-9(June 1962).

The partial differential equations describing thermal processes in the reactor core are solved with respect to the coolant temperature in two cases: that in which the fuel element temperature is averaged over the fuel element cross sectional area; and that in which the temperature distribution in this cross section is taken into account. It is assumed that the fuel element is of the rod type, that there is no conduction in the longitudinal direction, and that the inlet coolant temperature is a constant. The results obtained as solutions of these equations are discussed from the point of view of the application of an analog computer to the exact simulation of thermal processes in the reactor core. (auth)

22315 A SIMPLIFIED DYNAMIC MODEL FOR THE VIBRATION FREQUENCIES AND CRITICAL COOLANT FLOW VELOCITIES FOR REACTOR PARALLEL PLATE FUEL ASSEMBLIES. G. S. Rosenberg and C. K. Youngdahl (Argonne National Lab., Ill.). Nuclear Sci. and Eng., 13: 91-102(June 1962).

The response of flat, thin, parallel, metal fuel elements to the loads imposed by the flow of coolant through reactor core passages is examined for the existence of plate divergence at velocities above a "critical" value. It is shown that small modifications of the simplifying assumptions used in the analysis produce a great difference in the conclusions regarding the possibility of divergence and the interpretation of the "critical" coolant velocity. Fluid inertia effects are included in the analysis of the periodically supported plates. Although agreement exists between the results of the dynamic model and that of "neutral equilibrium," the additional consideration of fluid inertia leads to a different interpretation of "critical" velocity for the periodically supported plates. (auth)

Instrumentation

Refer also to abstracts 22928, 22929, 22930, and 23005.

22316 (AD-269309) WEAK-BEAM PHASE-BRIDGE MEASUREMENT OF INTERACTION IMPEDANCE. Final Report. R. P. Lagerstrom, D. A. Dunn, and P. A. Brennan (Stanford Univ., Calif. Electron Devices Lab.). July 29, 1960. Contract NONR-225(25). 44p. (TR-490-1)

A weak electron beam is operated at full circuit voltage to perturb the phase delay along a slow-wave structure. The beam current is typically on the order of one-thirtieth of Kompfner-dip current or backward-wave start-oscillation current. The phase perturbation is measured on a simple phase bridge made of ordinary standing-wave-measurement equipment. The circuit-interaction imped-

ance is calculated from this datum. Space-charge effects can be neglected without error. Since the beam is a velocity-sensitive perturbation, it can distinguish between different space-harmonic waves, between backward and forward waves, and between modes on some multimode circuits. Circuits intended for pulsed high-power operation can be perturbed with d-c beams without exceeding their dissipation ratings. Weak-beam data are compared favorably with forward-wave and backward-wave impedance data taken by the conventional methods on a tape helix. The weak-beam data are probably more reliable because of the lack of space-charge effects. (auth)

22317 (AD-269972) RESEARCH INVESTIGATION OF P-I-N ELECTRON JUNCTION DETECTORS. Interim Engineering Report No. 2, October 1, 1961 through December 31, 1961. (Hughes Research Labs. Div. of Hughes Aircraft Co., Malibu, Calif.). Jan. 1962. Contract NObsr 85511. 7p.

The operation of a spherical lithium-drifted p-i-n detector as a photon counter was examined. When the depletion width is about 2 mm, the efficiency for counting Co^{60} photons is 6%. The detector is quite symmetrical when used as a 4 pi counter for these photons. (auth)

22318 (AD-270014) FEASIBILITY STUDY OF AQUEOUS TRICHLOROETHYLENE DOSIMETRY. Final Report. R. A. Glass, W. E. Wilson, and A. H. Samuel (Stanford Research Inst., Menlo Park, Calif.). July 31, 1961. Contract DA-18-108-CML-998. 121p.

The program for determining feasibility of the trichloroethylene (TCE) system involved: preparation of dosimeters; development of a spectrophotometric reading system to determine pH values from optical absorbance values (with precision not obtainable from visual observation of color change); determination of pre- and post-irradiation stability; and gamma irradiations of dosimeters at both low- and high-dose rate and low and high temperature to determine dosimeter response and reproducibility of response. The chief conclusion is that the aqueous TCE dosimetry system may ultimately satisfy military requirements. At present such operations as culling of dosimeters from preparation batches, aging of dosimeters before and after irradiation, and calibration of dosimeters for response would be necessary to produce a satisfactory set of field dosimeters. (auth)

22319 (AEET/RMS/6) GLASS DOSIMETRY—A BIBLIOGRAPHY. Shri A. V. Raghunath, comp. (India. Atomic Energy Establishment, Trombay). Apr. 1962. 18p.

This bibliography consists of 92 references and covers the literature which was available up to the end of December 1961. The references are arranged in chronological order. An author index and sources used in the compilation are also included. Abstract references are given wherever possible. (auth)

22320 (AERE-R-3063) THE ABSOLUTE CALIBRATION OF GAMMA RADIATION DOSIMETERS BY CALORIMETRY. D. B. Dove and B. G. Cole (United Kingdom Atomic Energy Authority. Research Group. Wantage Radiation Lab., Harwell, Berks, England). Dec. 1959. Reprinted May 1962. 39p.

The theory and techniques of the calorimetric calibration of gamma radiation dosimeters are discussed. Details are given of the construction and operation of an isothermal calorimeter, together with the results of a dosimeter calibration. (auth)

22321 (ARF-1164-24) RESEARCH STUDY ON NEUTRON INTERACTIONS IN MATTER AS RELATED TO IMAGE FORMATION. Period Covered January 1, 1962 to March 31, 1962. H. V. Watts (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Apr. 27, 1962. Contract AT(11-1)-578. 21p.

The imaging qualities and the thermal neutron and gamma sensitivities of several neutron imaging detectors, including the indium activation-transfer technique, the direct indium foil-film exposure technique, a Li^6F-ZnS(Ag) phosphor screen with film, and a B^{10}-ZnS(Ag) phosphor screen with film, were studied. It was observed that, although the sharpness of the image suffered somewhat, the phosphor screens were 1,000 to 10,000 times faster than the direct indium exposure or indium transfer technique. Neutron exposures of about 5×10^3 n/mm^2 were sufficient to produce an optical density of 1.0 on type F film with the phosphors. The gamma response of all of these imaging devices was sufficiently low that the gamma intensity in the reactor thermal neutron beam does not affect the image. The image degradation effect of 1", 3", and 6" thicknesses of graphite scatterer behind the absorption object in the 5" diameter reactor neutron beam was demonstrated. Also the effect of a 1", 3", and 6" object to detector spacing was determined There was an appreciable image degradation due to the large effective "focal spot" size of the reactor neutron source. Various applications of neutron radiography are discussed. (auth)

22322 (DC-60-6-174) STATUS REPORT — 2400 CYCLE MAGNETIC AMPLIFIERS. S. F. Hemmenway, Paul K. Hiser, and Jack A. Russell (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). June 29, 1960. Contract AT(11-1)-171. 30p.

The advantages of using a 2400 cps magnetic amplifier over a 400 cps magnetic amplifier are detailed. The 2400 cps magnetic amplifier and three 2400 cps power sources are discussed. Operational data of the amplifier with the power sources showed achievement of the design objectives of fast response and small size. (auth)

22323 (DC-61-3-743) INVESTIGATION OF INDUCED NOISE ATTENUATION TECHNIQUES IN PULSE DETECTION SYSTEMS. T. B. Klingler (General Electric Co. Aircraft Nuclear Propulsion Dept., Idaho Falls, Idaho). Mar. 30, 1961. Contract [AT(11-1)-171]. 37p.

Maintaining radiation monitoring systems free from the detrimental effects of interference type noise was a problem in some of the reactor operating facilities at the Idaho Test Station. An outline is presented of techniques which were used to eliminate these problems. The investigations were made on special detection-noise generating systems set up in the Instrument Engineering Laboratory and on the actual facility systems. (auth)

22324 (DOFL-TR-1050) EXTENDED APPLICATION OF A COBALT GLASS DOSIMETER. William T. K. Johnson (Diamond Ordnance Fuze Labs., Washington, D. C.). June 5, 1962. 25p.

Cobalt glass dosimeters, normally used to measure gamma ray and electron fields, were used to measure gamma ray and coexistent thermal neutron fields in the presence of a fast neutron field. The dosimeter is darkened in proportion to the energy deposited and this darkening is calibrated in known gamma ray and thermal neutron fields. A three-glass sandwich was used to distinguish the effects of gamma rays and thermal neutrons. The sensitivity of the glass to various energy gamma and x-rays is presented. A simple spectrophotometer is used to measure the transmission of light through the glass dosimeter. (auth)

22325 (DP-523) NEUTRON SPARK COUNTER. Frank P. Caiati (Du Pont de Nemours (E. I.) & Co.

Savannah River Lab., Aiken, S. C.). Oct. 1960. Contract AT(07-2)-1. 12p.

Spark counters of the wire-plate type are rugged and simple, and their sensitivity is directly proportional to the specific ionization of incident particles. Spark counters are insensitive to beta and gamma radiation but readily respond to alpha particles. With a suitable converter, the spark counter can also be employed as a neutron counter. Spark counters thus appear to be very good candidates for the measurement of neutron flux at reactor startup, where the high background of gamma radiation can be troublesome to other types of counters. A spark counter of cylindrical geometry was built and shown to have adequate sensitivity and stability for such duty. (auth)

22326 (HW-69471) AN INVESTIGATION OF THE OPERATIONAL CHARACTERISTICS OF THE PERLOW SPECTROMETER (thesis). J. S. Loomis, Jr. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 2, 1961. Contract AT(45-1)-1350. 148p.

The results of calibration and testing of three Perlow spectrometers prior to their contemplated use on reactor shielding neutron spectra are presented. The philosophy of neutron spectrographic detection and fast neutron instrument calibration is outlined. The tools and techniques of fast neutron instrument calibration are described. The theory and operation of the Perlow spectrometer are discussed. (M.C.G.)

22327 (NARF-61-36T) NUCLEAR EMULSION TECHNIQUES FOR THE MEASUREMENT OF FAST-NEUTRON ENERGY SPECTRA. C. S. Warren (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.). May 15, 1962. Contract AF33(657)-7201. 70p. (FZK-9-159)

Techniques developed to determine fast-neutron spectra with nuclear emulsions are described in detail. The general theory involved in the exposure of nuclear emulsions is developed along with descriptions of procedures and equipment used. Data obtained with nuclear emulsions are presented and discussed. (auth)

22328 (TID-15748) STUDIES OF A MULTIPLE-WIRE PROPORTIONAL COUNTER (thesis). Billy Seay Thomas (Vanderbilt Univ., Nashville). June 1955. 32p.

A proportional counter was designed and built for use as part of a gas filled proton recoil neutron spectrometer. The spectrometer consists of two of the counters in tandem, with a system of long metal tubes in between for collimating the protons. The counters are connected in a coincidence arrangement to the recording equipment so that only protons that ionize in both chambers will be counted. Results of testing the counter indicated that it did not have sufficient resolution to be very useful. Some modifications of the present design are suggested. (auth)

22329 (TID-16021) DEVELOPMENT LEADING TO AN IMPROVED DENSITOMETER FOR HELIUM-GRAPHITE OR NITROGEN-GRAPHITE FLOW STREAMS. Quarterly Report No. 189-6, February, March, and April 1962. Donald H. Strobel (Badger Meter Mfg. Co., Milwaukee). May 21, 1962. Contract AT(11-1)-1111. 23p.

The design and function of the various components of the closed-loop servo-densitometer using radioisotopes for the density sensing transducers are described. The densitometer is being developed for measuring the density of helium-graphite and/or nitrogen-graphite mixtures. Calibration is independent of isotope decay, detector gain changes, servo-component gain changes, ambient nuclear radiation, or flow stream radiation. The meter readout is in the form of a readout dial and/or an electrical signal suitable for use with a strip chart recorder. (N.W.R.)

22330 (TID-16041) MEASUREMENT OF BREMSSTRAHLUNG DOSE AND SPECTRUM FROM A 600 KVP PULSED X-RAY GENERATOR USING PHOTOGRAPHIC FILM. G. H. Bouchard (Sandia Corp., Albuquerque, N. Mex.). June 1962. Contract [AT(29-1)-789]. 21p. (SCDC-2688)

The properties of the interaction of bremsstrahlung radiation from a 600 kvp x-ray unit with various materials are presented. The physical features of the 600 kvp Foxitron flash x-ray system as a radiation source show that it has a beam of radiation along the axis of the x-ray rube. The beam behaves as though it emanates from a point source; its intensity decreases in proportion tp the square of the distance from the source. The energy spectrum is estimated by calculating the response of photographic films under various filters to a postulated energy spectrum and comparing these results to those actually measured with filtered film. The procedure is continued until the results are in agreement. (auth)

22331 (TIM-669) INVESTIGATION OF VIBRATION TRANSDUCERS FOR REACTOR USAGE. S. Fanciullo (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown). May 3, 1961. Contract [AT(11-1)-229]. 5p.

An investigation was made to find a vibration pickup capable of operating in a gamma radiation environment to a total dose of 5×10^{10} ergs g^{-1} and with a frequency range of 20 to 150 cps with forces less than 1 g. (M.C.G.)

22332 (USNRDL-TR-559) PRECISION MAGNETIC FIELD MEASUREMENTS USING HALL GENERATORS. T. S. Dahlstrom, H. A. Howe, W. M. Mallet, and W. E. Smith (Naval Radiological Defense Lab., San Francisco). Apr. 24, 1962. 45p.

Accelerators employing magnetic fields require accurate measurement of these fields. Employment of the Hall effect in the recently developed semiconductors, indium-arsenide and indium-antimonide, meets these strict magnetic field measurement requirements. The semiconductors have the following approximate characteristics depending upon the size and type of semiconductor. At the rated current through the semiconductor, the Hall voltage is about 0.1 v at 10 kgauss. The temperature coefficient is small (approximately 0.07%/°C) but varies as much as 50% for different magnetic fields. The long time stability is good with a measured variation over a year of less than 1 part in 10,000. Semiconductors with effective dimensions from 1 to 12 mm are available. With a special value of electrical load on the output terminals linearity better than 0.5% is obtainable from 0 to 10 kgauss. A detailed description of the temperature coefficient of the Hall potential, the internal resistance of the semiconductor, will be presented along with a description of a temperature compensating network which yields a magnetic field measuring probe with a temperature coefficient of less than 0.01%/°C over a magnetic field range from 6 to 25 kgauss. The importance of thermal time constants of the semiconductor will be discussed and some measurement results presented. (auth)

22333 (WCAP-1874) DEVELOPMENT OF MINIATURE SiC NEUTRON DETECTORS. Quarterly Progress Report for Period Ending September 30, 1961. J. Weisman (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). Oct. 1961. Contract AT(30-1)-2827. 14p.

Work on the development of miniature silicon carbide neutron detectors is reported. A major problem area is

the development of surface junctions suitable for neutron detection. Diffusion techniques appear highly promising for the production of such junctions. Accordingly, a new diffusion furance for accomplishing this has been set up and a diffusion process designed. Another important area is the evaluation of the junctions under simulated operating conditions. A high temperature furnace, to be used in conjunction with the Van de Graaff generator, for irradiation annealing and counting studies, is being constructed. A brief, preliminary study of annealing of radiation damage in bulk SiC was conducted. (auth)

22334 (WCAP-1929) DEVELOPMENT OF MINIATURE SiC NEUTRON DETECTORS. Quarterly Progress Report for Period Ending December 31, 1961. J. Weisman, ed. (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). Jan. 1962. Contract AT(30-1)-2827. 14p.

Work on the development of miniature silicon carbide neutron detectors is reported. Progress was made in the development of surface junctions suitable for neutron detection. Diffused junctions as shallow as 2 to 3 microns were prepared. Electrolytic etching and contacting procedures were investigated for the preparation of a diode suitable for radiation testing. The bombardment and annealing furnace, to be used in conjunction with the Van de Graaff generation for irradiation annealing and counting studies, was constructed and tested. (auth)

22335 (JPLAI-tr-27) RADIOFREQUENCY MASS SPECTROMETER FOR THE INVESTIGATION OF THE ION COMPOSITION OF THE UPPER ATMOSPHERE. V. G. Istomin. Translated by J. L. Zygielbaum (California Inst. of Tech., Pasadena. Jet Propulsion Lab.) from Iskusst. Sputniki Zemli, No. 3, (1959). 40p.

A radio-frequency mass spectrometer for the investigation of the ion composition of the earth's upper atmosphere is described. The construction of the instrument and its component parts is discussed. A method of operation with a mass spectrometer is presented, followed by a representational listing of the normal operational modes of the instruments. (auth)

22336 4-π PROPORTIONAL COUNTER FOR THE ABSOLUTE MEASUREMENT OF ACTIVITIES. N. Martalogu, A. Calboreanu, and I. Neamu. Acad. rep. populare Romîne, Inst. fiz. atomică si Inst. fix., Studii cercetări fiz., 12: 893-7(1961). (In Rumanian)

The counter is a sphere and is filled with methane at different pressures. Operating in proportional regime with an adequate electronic system, it gives a large amplification with a satisfactory signal/noise ratio. With a P^{32} source a slope whose characteristics depend on pressure was obtained. (tr-auth)

22337 A SOLID-STATE POTENTIOSTAT. J. E. Harrar, F. B. Stephens, and R. E. Pechacek (Univ. of California, Livermore). Anal. Chem., 34: 1036-7(July 1962).

A potentiostat was developed in which only solid-state circuit components are used. The instrument uses an operational amplifier as the principal control element. The circuit is described, and a wiring schematic diagram is shown. Electrical characteristics of the potentiostat are listed. (M.C.G.)

22338 A CONTROLLED SCINTILLATION CHAMBER HAVING AN OPERATIONAL SCINTILLATING VOLUME OF 2500 Cm^3. Yu. K. Akimov, M. M. Butslov, O. V. Savchenko, and L. M. Soroko. Atomnaya Energ., 12: 413-15(May 1962). (In Russian)

The chief merit of the device consists in the junction of fast-acting scintillation counters with the possibility of the visual observation of the tracks of charged particles. The chambers are useful for studying uncommon decay schemes of unstable elementary particles taking place on an extraneous radiation background. A chamber with a volume of 2500 cm^3 was prepared and was used for taking photographs of the tracks of cosmic particles. The useful volume of the device was greatly enlarged by employing a single-chamber electron-optical transformer with a 150-mm-diameter photocathode and about 1-mm-thick glass walls. The scintillator consisted of about 20,000 filaments placed in alternating, mutually perpendicular layers, separated by black paper for absorbing the scattered light. The apparatus may be used for the study of β decay of π^+ mesons according to $\pi^+ \rightarrow \pi^0 + \gamma$, for the investigation of the rare decay modes of μ mesons, for the study of deuteron polarization phenomena in the $p + p \rightarrow d + \pi^+$ reactions, for the study of the polarization of proton beams, etc. (TTT)

22339 USE OF α-SCINTILLATION CHAMBERS FOR THE DETERMINATION OF RADIUM ISOTOPES BY THE EMANATION METHOD. S. S. Lenin, N. N. Shashkina, and V. L. Shashkin. Atomnaya Energ., 12: 429-31(May 1962). (In Russina)

The radiochemical method of determining the Ra isotopes by measuring the activity of the emanations usually requires at least 1×10^{-11} curie of Rn. The sensitivity of the determinations may be increased by the use of proportional counters, pulsed ionization chambers, or α-scintillation chambers. The latter method is the most satisfactory in view of its simplicity: it involves the joint use of a special scintillation-type emanation chamber together with a pulse recording device. The internal surface of the cylindrical chamber is covered with a 50 to 100 mg/cm^2 thick ZnS layer. The separate determination of Rn, RaA, and RaC′ presents some problems. The background depends on the contamination of the walls by α-emitters. The sensitivity of the method makes it possible to measure samples containing 8×10^{-13} curie of Rn with a relative error of 20%. The ThX content of samples containing 3.2×10^{-5} g of Th was successfully determined with a relative mean square error of 13%. In view of the low half life of actinon $T_{1/2}$ = 3.92 seconds, the air must be passed faster through the chamber than in the case of Th determinations. AcX corresponding to 2.1×10^{-14} g of Ac could be determined. (TTT)

22340 AN ANTICOINCIDENCE RING FOR A WHOLE-BODY COUNTER. K. G. McNeill and L. D. Davis (Univ. of Toronto). Can. J. Phys., 40: 732-8(June 1962).

An account is given of an anticoincidence ring of plastic scintillator designed to fit round a 5 in. by 4 in. NaI crystal used as detector in a whole-body counter. This system can produce a marked diminution of the background and can be used to attenuate spectra of nuclides emitting gamma rays in cascade, thus helping in the analysis of complex spectra. (auth)

22341 DETERMINATION OF THE TRAJECTORY OF CHARGED PARTICLES BY MEANS OF A DETECTOR OF A NEW "BUBBLE HODOSCOPE" TYPE. George Charpak (CERN, Geneva). Compt. rend., 18: 3181-3(Apr. 30, 1962). (In French)

The trajectory of charged particles crossing a liquid containing bubbles can be made visible by provoking luminosity of the bubbles traversed by means of a static electric field. (tr-auth)

22342 A STUDY OF THE USE OF PROBES TO MEASURE POTENTIAL IN ELECTRON DEVICES. Richard Stephen Simpson (Univ. of Florida, Gainesville). Dissertation Abstr., 22: 2740-1(Feb. 1962).

A study was made to evaluate the performance of both

non-emitting and emitting probes when used to measure potential in electron streams. Accomplishment of this objective required the building of a cylindrical diode and a beam-type device into which probes could be inserted. The latter device was constructed so that the negative space charge of the electron beam could be neutralized by positive ions if desired. Both these devices were relatively large in order that the probe perturbation would be as small as possible. The probes used were miniaturized as much as was feasible. Through experimentation a non-emitting probe was developed which performed quite satisfactorily. The emitting probe was temperature-modulated in order to provide a method for detecting its emission. Results obtained with this probe were slightly better than those obtained with the non-emitting probe when positive ions were not present. The presence of ions had an adverse effect on the emitting probe. These probes were found to provide an acceptable method for measuring potential in electron streams. The non-emitting probe proved to be a simple, versatile, and accurate device. It performed well in both ion-neutralized and unneutralized electron streams. The emitting probe, although more complex than the non-emitting type, resulted in slightly more accurate measurements when used in unneutralized electron streams. It was found not to be well adapted for use in the neutralized beams.

22343 THE DIRECT CONVERSION OF HEAT TO ELECTRICITY BY MEANS OF A NERNST EFFECT THERMOMAGNETIC GENERATOR. Stanley Wolff Angrist (Ohio State Univ., Columbus). Dissertation Abstr., 22: 3970 (May 1962).

The analysis of a device that utilizes the Nernst effect to convert heat directly to electricity without the use of any moving parts is presented. The analysis is given for both single stage and cascaded generators. A parameter, the index of performance which measures how well a given material will perform in a thermomagnetic generator, is defined as the square of the product of the Nernst coefficient and magnetic flux density divided by the product of the thermal conductivity and electrical resistivity. For extrinsic semiconductors, a high index of performance was found to be dependent on a large mobility, on a large effective mass, and on a small lattice thermal conductivity. No general rules can be given for intrinsic materials except that a high mobility and mobility ratio and low energy gap appear to be desirable characteristics. The value of the index of performance was calculated for a wide range of semiconductors whose indexes of performance vary over six orders of magnitude. Indium antimonide is shown to have the highest index of performance of any known material. The theoretical performance of a single, two- and three-stage Nernst generator was calculated. The efficiency of the Nernst generator, at present, is relatively low (less than 3 per cent), but the power density is relatively high (as much as 16 watts/cm^3) for temperature differences up to 400°K and magnetic flux densities of ten kilogauss. Economic, weight, and volume comparisons based on present information and trends indicate that the thermomagnetic generators will not be able to compete in these areas with thermoelectric units, either now or in the future. Special applications, such as power requirements of unusual frequency and/or amplitude, might be met by the utilization of the Nernst generator.

22344 A THEORETICAL AND EXPERIMENTAL ANALYSIS OF AN EIGHTEEN STAGE RADIO-FREQUENCY MASS SPECTROMETER. Gurdev Singh Bajwa (Univ. of Southern California, Los Angeles). Dissertation Abstr., 22: 4047-8(May 1962).

The design and development of an 18 stage radiofrequency mass spectrometer for use in conjunction with a 2 meter grazing incidence vacuum monochromator is discussed. The ions to be mass analyzed are accelerated by a d-c potential V_i into the analyzer, which consists of two sets of grids. Alternating potentials are applied to them, and in this way the ions gain an additional energy above V_i. A retarding potential V_r on a grid placed between the r.f. analyzer and the ion collector permits only those ions to reach the collector that have gained an energy equal to or greater than V_r. Both experiment and theory show that both the ion transmission and the mass resolution of such an instrument are controlled simultaneously by the values of maximum energy gain G_m and retarding potential V_r. It was demonstrated that G_m is uniquely determined by V_i and V_s/V_i, where V_s is the r.m.s. value of the analyzer signal. Therefore the peak ion collector current is proportional to the relative abundance of various ion species, provided the mass spectrum is obtained at a fixed value of ion injection energy V_i and analyzer signal V_s. This was verified by taking the mass spectrum of $ClCH_3$. Peak collector currents due to ions of mass 52 and 50 were in the ratio of one to three, which was in good agreement with the isotopic abundance of Cl^{37}(24.6%) and Cl^{35}(75.4%). A method is described to obtain ion abundance ratios from peak collector currents in the presence of small fluctuations in the analyzer signal. Due to the dependence of ion transmission on G_m and hence on V_i, ions of different masses have different transmissions when the mass spectrum is obtained by varying the ion injection energy V_i. This method, therefore, cannot be used for obtaining the ion abundance ratios. Simultaneous measurements of resolving power and ion transmission showed that the instrument gave best performance for V_s/V_i between 0.06 and 0.11. This corresponds to an energy gain of the tuned ions in the analyzer comparable to their initial energy. Outside of this range of optimum operation, the product of resolving power and transmission of the instrument decreased very rapidly. Undispersed radiation from a hydrogen glow discharge was used to obtain the mass spectrum of the parent and fragment ions produced by photoionization of various hydrocarbon vapors. The results showed that ions of different masses were completely resolved up to 30 atomic mass units, and the presence of adjacent masses was detected up to 60 mass units.

22345 A PURE VAPOR CLOUD CHAMBER FOR THE STUDY OF ELECTRON AVALANCHES IN ARGON. Robert Poston Caren (Ohio State Univ., Columbus). Dissertation Abstr., 22: 4051(May 1962).

A cloud chamber was constructed which operates on pure argon vapor. Photographs were taken of electron avalanches in the argon gas. The electrons were produced by photoelectric emission and accelerated to produce the avalanches by an electric field giving E/P_0 values from 7.3 to 10.5 volts/cm mm of Hg. The electric field was produced by the thyratron switching of a high voltage coaxial line. Electron mobilities were measured in the range of E/P_0 values from 7.3 to 10.5 volts/cm mm of Hg. The electron mobility appeared to be independent of E/P_0 in this range and had an average value of about 3.3×10^5 cm^2/volt sec mm of Hg. This electron mobility value was consistent with measurements of Herreng in pure argon gas in a slightly lower E/P_0 value. The pure vapor cloud chamber should prove useful as a device for measuring γ values at threshold breakdown conditions in argon and also for investigating possible avalanche to streamer transitions in argon at high E/P_0 values.

22346 STUDIES ON THE CHARACTERISTICS OF A PROPORTIONAL FLOW COUNTER. Hideo Teshima and Noriyoshi Morita. Dôitai to Hôshasen, 3: 127-35(Apr. 1960).

The proportional counter is preferable for detecting soft β rays emitted by tritium and C^{14} because of its simple structure, high sensitivity, and rapid responses. Various types of proportional counters for flow samples were evaluated. The characteristics of the counter are not affected greatly by its dimensions. The initial voltage, which becomes lower as the diameter becomes smaller, makes continuous discharge easier. Silver is somewhat unstable for the cathode, but platinum and gold are suitable. A tungsten anode, which is suitable because of its mechanical strength, gives a slightly higher starting voltage than a platinum anode. A mixture between 1:1 and 1:2 of Q-gas and propane gives the best results as the carrier gas. (OID)

22347 ISODOSE DETERMINATION WITH GLASS DOSIMETERS. R. Fischer, F. Schwabe, A. Unverricht, and W. Ahlendorf (Friedrich-Schiller-Universität, Jena, Ger.). Isotopentechnik, 2: 125-8(Apr. 1962). (In German)

Iso-dose determination with dosimetry glass is described. The method showed itself to be especially advantageous regarding the favorable approximate point-like photometric interpretation of the dosimeter glass plate. The simple operation of the glass dosimeter, its unlimited storage capacity for the radiation, and the constancy under radioinduced discoloration are further essential advantages. It is disadvantageous that for a significant iso-dose evaluation, high radiation doses of about 10^4 to 10^5 c must be established. (tr-auth)

22348 EXPERIMENTAL STUDY OF THE TIME RESOLUTION OF SCINTILLATION DETECTORS. Armand Sarazin, Jean-Jacques Samueli, and Christian Meynadier (Institut d'Etudes Nucléaires, Algiers). J. phys. radium, 23: 119-22(Feb. 1962). (In French)

The spread in the time resolution of scintillation detectors is studied as a function of the thresholds of the electronic apparatus. The influence of the parameters involved in time measurements is taken in account and a comparison is made with theory. (auth)

22349 CORRECTION FACTORS FOR THICK GOLD PROBES. D. Albert (Bereich Reaktortechnik und Neutronenphysik, Rossendorf, Ger.). Kernenergie, 5: 154-7 (Mar. 1962). (In German)

Correction factors for gold probes, which include the effect of neutron absorption during activation by thermal and epithermal neutrons (self-shielding) and absorption scattering (self-absorption and self-scattering), were experimentally determined, since for various thick probes the specific activity must be determined as a function of thickness. The probes were activated in isotropic neutron fields with and without cadmium shields. The detection of the activity was done with window (β detection) and scintillation (γ detection) counters. The results were compared with the values obtained for different counter geometries and with theoretical results and were discussed. (tr-auth)

22350 A TRANSISTORIZED ANTICOINCIDENCE DEVICE FOR LOW LEVEL MEASUREMENTS WITH GEIGER-MUELLER TUBES. R. Reichel (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Kernenergie, 5: 177-81(Mar. 1962). (In German)

For the measurement of very weak radioactive preparations in the presence of a corresponding low zero effect, frequently counter arrangements with anticoincidence shielding are used. With these devices it is possible to suppress the effect of energetic and relatively strongly ionizing meson components of cosmic radiation, which, because of their penetrating power, are only slightly attenuated by the usual lead chambers. A simple transistorized anticoincidence device and the auxiliary tube container, developed especially for the recording of the β absorption curves of very low intensity sources, are described. With a commercial window counter in the measurement circuit, values of approximately 3 cpm for the zero effect were obtained. The results of some investigation on the characteristic zero effects of various counters are discussed. (tr-auth)

22351 FOG AND TRACK DENSITY IN AGFA-K 5 NUCLEAR EMULSIONS FOR DIFFERENT AMIDOL CONCENTRATION IN THE DEVELOPER. J. Baumann (VEB Filmfabrik Agfa, Wolfen, [Ger.]). Kernenergie, 5: 182-3(Mar. 1962). (In German)

Investigations with various amidol contents in the developer showed the possibility of developing Agfa-K 5 emulsions, which are sensitive to electrons at the ionizing minimum, by increasing the amidol concentration at pH 5.85. Very low fog grain counts were produced without damage to the track density. (tr-auth)

22352 INDUSTRIAL APPLICATIONS OF β-RAY EXCITED X-RAYS. VI. THE FLUORESCENT X-RAY AND ITS APPLICATIONS. [PART] III. Shigemasa Enomoto and Chizuo Mori. Nagoya Kôgyô Gijutsu Shikenjo Hôkoku, 10: 94-100(Feb. 1961).

The photon-energy response of a gas-flow type proportional counter, such as the pulse height counter on the energy resolution was studied experimentally using a Sr^{90}–Y^{90} β-ray excited x-ray source. The plateau characteristics of the proportional counter showed that discrimination between α and β rays, or between x rays of different energies was practicable by adjusting the high voltage of the counter. The energy spectrum of the bremsstrahlung produced by Sr^{90}–Y^{90} β ray was calculated by the Wyard method and agreed with the data obtained by a NaI(Tl) scintillation energy spectrometer. The energy resolution of the counter was inversely proportional to the square root of the x ray energy, and the resolution for the Cu K x ray (8.0 kev) and Ti K x-ray (4.5 kev) were about 20 and 40%, respectively. (OID)

22353 FUNDAMENTAL STUDIES ON MEDICAL RADIOISOTOPE SCANNING. I. SENSITIVITY AND RESOLUTION OF COLLIMATORS. H. Kakehi, N. Arimizu, and M. Nakano (Chiba Univ. School of Medicine, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 20: 2789-95(1961).

Iso-response curves were made with a I^{131} point source and with various collimators such as cylindrical cone, inverted tapered cone, or 2-inch honey cone. The NaI crystal was 2 inches in diameter and 2 inches in height. As a rule, the shapes of iso-response curves in human tissues were a little shortened in the axial direction of the hole of the collimator as compared with those in air. In calculating the areas of curves of more than 10% response, there was little difference between differential and integral computation, but with less than 5% response integral computation gave a much larger area than differential. From the half maximum heights on the axis of the collimator at a certain distance, resolution curves were constructed both in air and in material equivalent to tissue and there was no noticeable difference between integral and differential calculation. Therefore, the resolution of the collimator is influenced only by its own geometrical properties and not by scattered rays. (auth)

22354 STUDY OF DISTORTIONS IN NIKFI-R EMULSIONS. PART I. INFLUENCE OF FIXATION PROCESS. I. Hauser (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Nuclear Instr. & Methods, 15: 129-36(Mar. 1962). (In German)

The distortions in emulsions fixed in hyposolutions,

which have concentrations varying between 15 and 50% and a constant pH value are measured. The experiments are carried out with three batches of emulsions. All distortion vectors K vary from about 2 to 20 μ, independent of the treatment of the emulsion. It is found, however, that in each emulsion a preferred direction of the distortion vectors exists, except for those near the edges. The methods of measurement and calculation of the distortion vector and its error are discussed. (auth)

22355 A FAST NEUTRON TIME-OF-FLIGHT SPECTROMETER. C. F. Cook (Phillips Petroleum Co., Bartlesville, Okla.). Nuclear Instr. & Methods, 15: 137-45 (Mar. 1962). (In English)

A time-of-flight spectrometer to measure the neutron energy spectrum and the angular distribution of elastically and inelastically scattered fast neutrons is described. The spectrometer is of the associated-charged-particle type. The time resolution of the spectrometer is 2 nsec. The ultimate resolution of this spectrometer is less than 0.5 nsec; limitations are due to photomultiplier quality. The linearity of the spectrometer response is determined over the range of 0 to 100 nsec. A typical inelastic scattered spectrum from 14.6-Mev neutron bombardment of carbon is presented. A level in C^{12} at 10 Mev excitation energy is reported. Other groups of neutrons corresponding to the ground state and the 4.43-Mev level are also reported. (auth)

22356 RESOLUTION AND LUMINOSITY OF CRYSTAL SPECTROMETERS FOR NEUTRON DIFFRACTION. C. Caglioti and F. P. Ricci (Comitato Nazionale per l'Energia Nucleare, Ispra and EURATOM, Ispra, Italy). Nuclear Instr. & Methods, 15: 155-63(Mar. 1962). (In English)

Theoretical results on resolution and luminosity of crystal spectrometers for neutron diffraction are extended, in view of useful applications to the concept of automatic data collection by means of such spectrometers (e.g., for single-crystal analysis). Furthermore, experimental tests showing agreement with the theoretical results are presented and discussed. (auth)

22357 EVALUATION OF THE ABSOLUTE ACTIVITY OF ALPHA EMITTERS AND OF THE NUMBER OF NUCLEI IN THIN ALPHA ACTIVE LAYERS. A. J. Deruytter (Laboratorium Verschaffelt, Rijksuniversiteit, Ghent and CEN, Mol, Belgium). Nuclear Instr. & Methods, 15: 164-70(Mar. 1962). (In English)

The main reasons for the inaccuracy in absolute alpha activity determined with a 2π geometry counter, i.e., self-absorption and backscattering, are studied experimentally and compared to theoretical predictions. For very thin layers ($\leq$10 $\mu g/cm^2$) the agreement is within 1%, and for layers up to 50 $\mu g/cm^2$, it is within 2%. For thicker layers, the discrepancies are larger. A method is developed to determine the number of nuclei in a thin layer from a measurement of the α activity, by comparison of the unknown layer to standards of the same isotopic composition in a low-geometry counter. An accuracy of 0.5% is achieved for layer thicknesses up to 1 mg/cm^2. The method is checked by an isotope dilution technique and a 2π geometry counter. (auth)

22358 ELECTRONIC ELIMINATION OF NOISE PULSES IN SCINTILLATION COUNTING. C. J. S. Damerell (Univ. of Cape Town, S. Africa). Nuclear Instr. & Methods, 15: 171-7(Mar. 1962). (In English)

The possibility of developing a single-tube alternative to the double tube coincidence technique for noise-pulse elimination in scintillation counting is considered. A circuit that operates satisfactorily with scintillators having decay times of 200 nsec or longer (such as NaI(Tl) or (CsI(Tl)) is described. The feasibility of an extension of the method for use with the organic scintillators is indicated. (auth)

22359 LINEAR PREAMPLIFIER OF LOW NOISE FOR JUNCTION DETECTORS. S. Gorodetzky, M. Port, and J. Graff (Institut de Recherches Nucléaires, Strasbourg). Nuclear Instr. & Methods, 15: 183-7(Mar. 1962). (In French)

A description is made of a low-noise preamplifier using RCA Nuvistor triodes. The preamplifier is linear and designed to be used in spectroscopy with solid state detectors. The intrinsic resolution of the whole electronic circuitry is about 5 to 8 kev. The lowest dispersion at half maximum obtained with a detector is [illegible] kev for 5.3-Mev alpha particles (Po^{210}). Using this spectrometer the separation of the two alpha groups α_0 and α_1, leading to the two first excited states of O^{14} by the $F^{19}(p,\alpha)O^{16}$ reaction is achieved. The energy difference of these two groups is about 60 kev at the detector angle. The alpha energy at the proton energy setting (1.880-Mev resonance) is 2.75 Mev. (auth)

22360 A SYSTEM FOR STABILIZING THE GAIN OF A SCINTILLATION SPECTROMETER. K. W. Marlow (Naval Research Lab., Washington, D. C.). Nuclear Instr. & Methods, 15: 188-92(Mar. 1962). (In English)

A gain-stabilizing system for use with a scintillation counter is described. The system uses a small lamp (6977) as a stable reference to correct the gain of the photomultiplier and amplifier. A stabilizing factor of 330 is obtained. When used in conjunction with a multichannel analyzer calibrated for 15 kev per channel, gamma ray peaks at 34.10 and 85.41 channels (on the average) show root-mean-square deviations of 0.05 and 0.04 channels respectively, for measurements made over a period of 23 hours. (auth)

22361 ION BEAM CONTROL IN A DUOPLASMATRON SOURCE. L. E. Collins and R. J. Brooker (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Nuclear Instr. & Methods, 15: 193-6(Mar. 1962). (In English)

The extraction of an intense ion beam depends largely on the shape of the plasma boundary and ion density. If the plasma density is too high a protruding plasma cap is formed and the ion beam becomes very divergent. A method of automatically controlling the plasma density to prevent this occurrence is described. (auth)

22362 A SIMPLE ELECTRON GUN FOR USE IN ELECTRON SCATTERING STUDIES. William Parker (Chalmers Univ. of Tech., Göteborg), Carl-Joel Andreen, and Hilding Slaetis. Nuclear Instr. & Methods, 15: 200-2 (Mar. 1962). (In English)

The design, construction, and performance of a simple electron gun is described, whose principal advantage is the employment of a filament derived from an ordinary pocket-torch lamp bulb. The described electron gun, used in electron scattering studies, proves suitable as a source of low-energy electrons and requires a minimum of service. The angular distribution of the electron beam intensity is presented. (auth)

22363 NOMOGRAM FOR NEUTRON TIME-OF-FLIGHT SPECTROMETRY. H. Teutsch (Institut für Atomphysik, Bucharest). Nuclear Instr. & Methods, 15: 203-4(Mar. 1962). (In German)

A nomogram for various parameters of neutron time-of-flight spectrometry is given, which allows a rapid determination of all experimental conditions. The two upper

parts of the nomogram depend on the chopper used and are plotted for the parameters of a particular chopper with curved slits, but an analogous nomogram can be easily constructed for any chopper and energy range. (auth)

22364 HIGH EFFICIENCY SMALL VOLUME G-M DETECTOR. Carl-Joel Andreen (Chalmers Univ. of Tech., Göteborg), William Parker, and Hilding Slaetis. Nuclear Instr. & Methods, 15: 205-6(Mar. 1962). (In English)

A small G-M detector is described that uses a toroidal geometry for the gas chamber in order to achieve high sensitivity. The torus has a coaxial wire anode that uses a voltage up to 1.5 kv, with a plateau length of about 150 v in an Ar–propane mixture. The detector is designed to be placed close to electron-bombarded targets to detect backscattered electrons without interfering with the primary electron beam. (T.F.H.)

22365 A LIQUID DEUTERIUM TARGET REFRIGERATED BY LIQUID HYDROGEN. G. Moneti and V. Montelatici (Comitato Nazionale per l'Energia Nucleare, Ispra, Italy). Nuclear Instr. & Methods, 15: 207-8(Mar. 1962). (In English)

A 310-cm^3 cell containing D_2 at 300 Torr is cooled by the evaporation of liquid H_2. The cooling process dissipates 1.5 l of H_2 the first hour, and 0.15 l/hr thereafter. The D_2 cell is a Ni cylinder with several outer concentric cylindrical Cu radiation shields and an outer vacuum chamber. Windows are provided for beam entry and exit. The residual pressure in the vacuum chamber is about 10^{-6} Torr. The D_2 cell can be flushed by passing a current through a carbon resistor in the cell, thus evaporating the liquid. (T.F.H.)

22366 TOTAL INTERNAL CONVERSION COEFFICIENTS OF LOW ENERGY CASCADE GAMMA-RAYS BY A SUM COINCIDENCE TECHNIQUE. S. K. Sen and B. G. Hogg (Univ. of Manitoba, Winnipeg, Can.). Nuclear Instr. & Methods, 15: 209-10(Mar. 1962). (In English)

A cascade decay scheme is considered in which γ_1 is followed by γ_2, and all decay occurs to the second level. Simultaneous conversion electron and gamma detection signals are fed into a coincidence counter; the signal energies are added; and the energy sum is fed into a single-channel analyzer that is sensitive both to the sum of the γ_1 energy and the energy of the conversion electrons of the γ_2, and to the sum of the γ_2 energy and the energy of the conversion electrons of the γ_1. From an analysis of the areas under the electron and gamma spectral curves, as well as the photopeak efficiencies of the gamma detector at the energies of γ_1 and γ_2, the respective total internal conversion coefficients of the γ_1 and γ_2 transitions may be induced. (T.F.H.)

22367 A TELESCOPE PAIR SPECTROMETER FOR 5-20 Mev GAMMA-RAYS. F. Cvelbar, A. Hudoklin, M. V. Mihailović, and V. Ramšak (Nuclear Institute "Jozef Stefan", Ljubljana, Yugoslavia). Nuclear Instr. & Methods, 15: 211-12(Mar. 1962). (In English)

The spectrometer utilizes a Pb foil to generate electron-positron pairs, and an anticoincidence arrangement of scintillators to screen out extraneous pair-formation events. The pair energy is dissipated in a plastic scintillator tube, and the scintillation pulse is displayed in a 100-channel analyzer. Compton scattering events can be discriminated against. The spectrum measured by this arrangement for the reaction $B^{11}(p,\gamma)C^{12}$ is shown as an example. (T.F.H.)

22368 INTERACTION OF ADJACENT NEUTRON DETECTORS. G. Ronald Dalton (Univ. of Florida, Gainesville). Nuclear Sci. and Eng., 13: 190-6(June 1962).

The time- and speed-independent neutron transport equation in its integral form is applied to the calculation of the disturbed neutron flux in the vicinity of neutron detectors. The method is also applied to the calculation of the average flux in a two-detector system where the detectors are close enough to interact with each other. Hand methods of solving the integral equations are developed and shown to give results that are close to results of more accurate numerical methods of solving the integral equations. (auth)

22369 ELECTRON BEAM FLUX INTEGRATOR. N. G. Afanas'ev and A. V. Demyanov (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Pribory i Tekh. Ekspt., No. 2, 20-2(Mar.-Apr. 1962). (In Russian)

A device was designed for measuring electron beam flux at maximum energies of 100, 400, and 2000 Mev at 10^{-8} to 10^{-10} amp. The device is used for absolute calibration near targets. (tr-auth)

22370 ON SPECIAL APPLICATION OF WIDE-RANGE DOUBLE-FOCUSING SPECTROGRAPHS. V. F. Litvin (Leningrad State Univ.). Pribory i Tekh. Eksp., No. 2, 33-4(Mar.-Apr. 1962). (In Russian)

A double-focusing mass spectrograph with a special magnetic vector scheme was used for separating $e/m \sim 10$ to 20 by combining static electric and magnetic fields. Considering the three arbitrary parameters and the electric field parameters it is possible to attain, on the focal surface of the instrument, almost straight e/m lines. (R.V.J.)

22371 ABSOLUTE SENSITIVITY OF THICK-WALLED GRAPHITE IONIZATION CHAMBER AT UP TO 260 Mev PHOTONS. I. N. Usova (Inst. of Physics, Academy of Sciences, USSR). Pribory i Tekh. Ekstp., No. 2, 37-42(Mar.-Apr. 1962). (In Russian)

The absolute sensitivity of a thick-walled graphite chamber was calculated using the formulas derived by M. Lat (Phys. Rev., 72: 1961). The derived value is 20% lower than the published value. (tr-auth)

22372 ERRORS IN ELECTRON RECORDING DUE TO SCATTERING ON VACUUM CHAMBER WALLS AND AIR. I. A. Grishin, M. I. Kheifets, and A. M. Shenderovich (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Pribory i Tekh. Ekspt., No. 2, 43-6(Mar.-Apr. 1962). (In Russian)

The errors arising from scattering through the surrounding vacuum chamber walls and air are analyzed. The error is determined by three basic factors (the mean-square angle of scattering, counter angular dimensions, and angular distribution of particles). Formulas and graphs are included for various cases allowing the selection of the most suitable vacuum chamber dimensions, shape, and wall thickness. (tr-auth)

22373 CHERENKOV DIFFERENTIAL GAS COUNTER. A. S. Vovenko, B. A. Kulakov, M. F. Likhachev, A. L. Lyubimov, Yu. A. Matulenko, I. A. Savin, and V. S. Stavinskii (Joint Inst. for Nuclear Research, Dubna, USSR). Pribory i Tekh. Ekspt., No. 2, 49-52(Mar.-Apr. 1962). (In Russian)

Descriptions are given of a Cherenkov differential gas counter used for determining the total cross sections of K-meson and proton interactions at ~3 to 5 Bev/sec. (tr-auth)

22374 GAMMA DOSIMETER WITH PULSE TYPE GAS DISCHARGE COUNTER. V. V. Sidorenko, V. P. Ivanov, and K. F. Minin. Pribory i Tekh. Ekspt., No. 2, 55-8(Mar.-Apr. 1962). (In Russian)

A design is given of a γ dosimeter operating with a pulse-fed SI-3BG gas discharge counter capable of measur-

ing doses from 0.01 to 100 r at rates from 0.05 to 1000 r/h. The dosimeter can be utilized for remote control operations with 50 m between the transducer and the control board. (tr-auth)

22375 A NANOSECOND ANTICOINCIDENCE SCHEME. A. A. Ridenko (Inst. of Physics, Academy of Sciences, USSR). Pribory i Tekh. Ekspt., No. 2, 59-60(Mar.-Apr. 1962). (In Russian)

A nanosecond anticoincidence counter with a 100% efficient forbidden pulse control is described. The length and sign of forbidden pulses and coincidence pulses are identical. Positive pulses enter from both openings, and the three coincidence and forbidden channels operate with positive counter pulses. The multichannel system operates with a scheme of coincidences which is accomplished by differentiation of incomplete coincidence pulses by a channel opening free from pulses at the given moment. (tr-auth)

22376 MULTICHANNEL PULSE AMPLITUDE ANALYZER FOR IONIZATION CALORIMETER. V. N. Bolotov, M. I. Devishev, V. V. Filatov, and A. P. Shmeleva (Inst. of Physics, Academy of Sciences, USSR). Pribory i Tekh. Ekspt., No. 2, 66-70(Mar.-Apr. 1962). (In Russian)

A design is given of an amplifier analyzer with a large linear range and negative reverse communication, and a recording and control system for an ionization calorimeter is described. The scheme contains some elements of "memory" recording for ionization chamber pulses. The pulse recording system consists of a phase-inverted bridge system and POB-14 type oscillograph. (tr-auth)

22377 APPLICATIONS OF TELEGRAPH APPARATUS-STA FOR RECORDING DATA FROM MULTICHANNEL ANALYZER. Yu. A. Glukhov, A. A. Kurashev, G. P. Mel'nikov, and V. A. Sidorov (Inst. of Nuclear Energy, Academy of Sciences, USSR). Pribory i Tekh. Ekspt., No. 2, 70-5(Mar.-Apr. 1962). (In Russian)

Data accumulated in multichannel fast-neutron time-of-flight spectrometer systems are transferred by a telegraph apparatus to an ordinary telegraph tape with five lines of perforations on 17 mm paper tape. The rate of performance is one channel per second. The results are later computed with an electron calculating machine. (tr-auth)

22378 ELECTRON MULTIPLIER PERFORMANCE WITHOUT MEASURING SMALL PARTICLE FLUXES. V. G. Fleisher (Inst. of Physics and Tech., Academy of Sciences, USSR). Pribory i Tekh. Ekspt., No. 2, 115-19 (Mar.-Apr. 1962). (In Russian)

A method is suggested for determining the efficiency of electron multipliers and scintillation detectors by recording monochromatic particles without simultaneously recording the particle flux and counting the number of pulses. An analysis is made of the reduced efficiency related to the photoeffect and secondary emission statistics and to a certain discrimination level for cutting down the noises. It was observed that the mean amplitude relation to the energy is nonlinear for low-energy particles recorded by scintillation detector. The efficiency of secondary-electron type multipliers was evaluated. (tr-auth)

22379 NOISE DEPRESSION IN PHOTOELECTRON MULTIPLIERS FEU-13 AND 14. G. S. Vil'dgrube and Zh. M. Ronkin. Pribory i Tekh. Ekspt., No. 2, 119-20 (Mar.-Apr. 1962). (In Russian)

Methods are suggested for depressing noise levels in FEU-13 and FEU-14 multipliers by selecting incoming photomultiplier cascades (photocathode and modulator). The results show reduction of the noise by half and indicate that the photocathode and modulator are the principle noise sources. (tr-auth)

22380 SELECTION OF EFFICIENT OPERATING LEVEL FOR A PHOTOMULTIPLIER. L. V. Ksanfomaliti (Abastumanskaya Astrophysical Observatory, Academy of Sciences, Georgian SSR). Pribory i Tekh. Ekspt., No. 2, 121-3(Mar.-Apr. 1962). (In Russian)

The means for improving the performance of photomultipliers is suggested by selecting an efficient working point. It is shown that the fluctuation level has a minimum or a plateau at the region of high amplification. The effects of the light modulation frequency on the level of fluctuations are analyzed. (tr-auth)

22381 IMPROVED INTENSITY AND REDUCED FLASH EMITTED BY SPARK DISCHARGE. S. I. Andreev, M. P. Vanyukov, and E. V. Daniel (State Inst. of Optics, USSR). Pribory i Tekh. Ekspt., No. 2, 127-9(Mar.-Apr. 1962). (In Russian)

An improved intensity and reduced light flash duration emitted by a spark discharge are achieved by using metallic plates distributed perpendicularly to the discharge axis. (tr-auth)

22382 POWERFUL ELECTRON GUNS OPERATING IN DIFFICULT VACUUM CONDITIONS. A. K. Berezin, V. G. Stupak, G. P. Berizina, L. I. Bolotin, Yu. M. Lyapkalo, D. P. Solopikhin, and V. P. Bondarenko (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Pribory i Tekh. Ekspt., No. 2, 136-8(Mar.-Apr. 1962). (In Russian)

Construction of a pulse electron gun producting 20 a current in a pulse at 25 kw and operating in a vacuum at 5×10^{-5} mm mercury (equal to $\sim 5 \times 10^{-6}$ a/v conductivity) is described. (tr-auth)

22383 PULSED RADIOACTIVE SOURCE. Yu. A. Aleksandrov and Yu. I. Nechaev (Inst. of Physics, Academy of Sciences, USSR). Pribory i Tekh. Ekspt., No. 2, 168-9 (Mar.-Apr. 1962). (In Russian)

A radioactive source with 1 μsec pulse emission is described. (tr-auth)

22384 SPARK COUNTER WITH LARGE INTERELECTRODE INTERVALS. A. A. Borisov, B. A. Dologoshein, and B. I. Luchkov (Inst. of Physics, Academy of Sciences, USSR). Pribory i Tekh. Ekspt., No. 2, 170(Mar.-Apr. 1962). (In Russian)

The design and performance of a neon- and argon-filled $40 \times 30 \times 10$ cm^3 spark counter with electrode intervals of 4.5 and 10 cm are described. (R.V.J.)

22385 THE USE OF ALANINE AS A SOLID DOSIMETER. W. W. Bradshaw (Southwest Research Inst., San Antonio), D. G. Cadena, Jr., G. W. Crawford, and H. A. W. Spetzler. Radiation Research, 17: 11-21(July 1962).

Electron spin resonance has been found to be a satisfactory technique for the calibration and measurement of radiation doses by means of α-alanine dosimeters. Powdered α-alanine dosimeters have been calibrated for the measurement of doses from γ-, β-, proton, and x radiation in the range of 100 r to beyond 10^5 r. At low doses there are measurable differences in the number of free radicals created by each of the various types of radiation. The α-alahine is less sensitive to x rays than to the γ-rays, electrons, or protons studied so far. Plastic holders are satisfactory for measuring doses above 1000 r. Below 1000 r, better results are obtained with glass holders. However, selected quartz is to be preferred for general usage because of freedom from residual signals. Further studies in this laboratory are being conducted with quartz holders designed for optimum sensitivity. For some dosimeters, Teflon holders are recommended, since the ma-

terial itself can be made into a possible dosimeter also. Dosimeters from α-alanine were found to be stable, having about 5% decay after 90 days. (auth)

22386 CHARACTERISTICS OF METERING DEVICES FOR SPECTROMETERS IKS-11 AND IKS-12 WITH MODULATION OF THE RADIATION FLUX. A. F. Malnyev, M. P. Yoselson, and L. S. Kremenchugsky (Inst. of Physics, Academy of Sciences, Ukrainian S.S.R., Kiev). Ukrain. Fiz. Zhur., 6: 881-3(1961). (In Russian)

Investigations were made of the characteristics of metering devices for spectrometers. The metering devices have a reproducibility of spectral records of no less than 1.5%, and a slipping of the zero line of 1% of the complete scale of the device during a continuous seven-hour work period after warming up for 20 minutes. The application of the proposed metering device permits making the spectrometers precise instruments that can be used for quantitative measurements. (auth)

22387 MAGNETIC SPECTROMETER WITH INHOMOGENEOUS FIELD. I. F. Barchuk, G. V. Byelikh, V. I. Golyshkin, and A. F. Ogorodnik (Inst. of Physics, Academy of Sciences, Ukrainian SSR, Kiev). Ukrain. Fiz. Zhur., 7: 15-21(Jan. 1962). (In Ukrainian)

A description is given of a spectrometer with an inhomogeneous axial-symmetrical magnetic pole, focusing a wide beam of electrons at 180°. The spectrometer may be used as a Compton γ spectrometer with a thin organic radiator 16×130 mm^2 in area and resolution of 1 per cent for energy $E_\gamma > 1$ Mev, or as a β spectrometer. During measurement of β spectra the horizontal angle of capture may reach 70°. At an angle of capture of 30° with a β source of 0.5×16 mm^2 a resolution of 0.5 per cent can be obtained for the conversion line of Cs^{137} (0.6 Mev). Calculations of the focusing properties of the γ spectrometer and of its resolving power are presented. The instrument is designed for the study of γ spectra emitted by nuclei during the capture of thermal neutrons. (auth)

22388 AN INTERFEROMETER FOR SLOW NEUTRONS. H. Maier-Leibnitz and T. Springer (Technischen Hochschule, Munich). Z. Physik, 167: 386-402(1962). (In German)

After discussing the feasibility and possible usefulness of a neutron interferometer, an arrangement is described whereby Fresnel interferences were obtained for neutrons with wavelengths of about 4.4 Å in a 10-meter flight path with a 0.01 mm entrance slit, using two glass prisms instead of the Fresnel biprism. A useful separation of the two coherent beams of 0.06 mm was obtained. Possible improvements of the method are discussed. (auth)

22389 PRECISION MASS DETERMINATION WITH THE ELECTRIC MASS FILTER. U. von Zahn (Universität, Bonn). Z. Physik, 168: 129-42(1962). (In German)

The construction of an electric quadrupole spectrometer for precision mass determinations in the region A > 130 is described. The hyperbola-shaped electrodes are formed by sets of wires. A method is discussed which reduces the measurement of a mass ratio to a measurement of the ratio of two resistors. In contrast to the conventional "peak matching" technique, in this method the intensity ratio of both members of a doublet occurs as an additional parameter and has to be measured. For testing, measurements were done on Xe-isotopes. The mass ratios obtained are: $Xe^{132}/Xe^{131} = 1.007\ 632\ 1 \pm 5$, $Xe^{134}/Xe^{132} = 1.015\ 730$. The intensity ratio of Xe^{132}/Xe^{131} is 0.7872 ± 0.0020. These values are in good agreement with the most accurate measurements of Nier's laboratory. (auth)

22390 VERTICAL FOCUSING IN MAGNETIC ANALYSERS OF MASS SPECTROMETERS. R. N. Gall. Zhur. Tekh. Fiz., 32: 402-5(Apr. 1962). (In Russian)

Conditions of two-directional, horizontal and vertical, first-order focusing of paraxial beams of charged particles were studied in homogeneous and heterogeneous magnetic fields. The angle of deflection of ions in a mass analyzer was developed as functions of the field tangent for various horizontal and vertical focusing lengths (in uniform fields). Various two-dimensional magnetic prisms are discussed. (R.V.J.)

22391 LIQUID SCINTILLATION COUNTING — SOME PRACTICAL CONSIDERATIONS. Yutaka Kobayashi (Worcester Foundation for Experimental Biology, Shrewsbury, Mass.). 1961. 20p. $2.75 (Tracerlab., Inc., Waltham, Mass.).

Counting characteristics such as no self-absorption, high counting efficiencies for radioisotopes such as C^{14}, S^{35}, and H^3, and the ease of sample preparation, make liquid scintillation counting a practical method for the radioactive analysis of biological materials for β-emitters. The principles of the method are discussed and techniques are described. (C.H.)

22392 PENETRATIVE RADIATION COLLIMATOR. Walter P. Kern (to Baird-Atomic, Inc.). U. S. Patent 3,040,175. June 19, 1962.

A collimator for radiation detector calibration is described which may be simply made with any desired configuration. The collimator comprises a stack of a plurality of heavy metal strata provided with apertures for defining the desired solid angle increments. (D.L.C.)

22393 POSITIVE ION DETECTOR. Norman Richard Daly (to United Kingdom Atomic Energy Authority). U. S. Patent 3,041,453. June 26, 1962.

An ion detector for mass spectrometers is designed which has improved sensitivity, can suppress unwanted background signals, and can distinguish between ions of the same mass and charge but different numbers of constituent nuclei. The detector comprises a vacuum vessel with an aperture for passage of an ion beam, a thin foil of such thickness that the desired ions can penetrate the foil to liberate secondary electrons from the back but undesired ions cannot, and an electron detector for receiving the secondary electrons to produce signals. The detector is capable of distinguishing between H_2^+ and D^+ ions, between H_3^+ and HD^+ ions, and between He^+ and "air" ions. (D.L.C.)

22394 APPARATUS FOR NEUTRON-CAPTURE GAMMA RAY LOGGING. Stanley B. Jones, Thomas D. Mueller, and Paul E. Baker (to California Research Corp.). U. S. Patent 3,041,454. June 26, 1962.

A neutron-capture gamma ray logging system is designed with means for analyzing the gamma ray spectrum so that only one pulse height peak is recorded for each gamma ray energy. The system includes a neutron source, a shielded detector for the neutron-capture gamma rays, and a coincidence system with associated detectors surrounding the shielded detector for recording a pulse in the detector only if annihilation radiation is simultaneously detected in the associated detectors. (D.L.C.)

22395 APPARATUS FOR LOGGING NEUTRON-CAPTURE GAMMA RAYS. Walter E. Meyerhof (to California Research Corp.). U. S. Patent 3,041,455. June 26, 1962.

A neutron-capture gamma ray logging system is designed with means for simplifying the gamma pulse height spectrum by eliminating from it the continuum and two of

the three peaks for each gamma ray energy. The system has a first detector for detecting neutron-capture gamma rays and a second, annular detector surrounding the first detector for detecting the annihilation radiation to trigger the measurement of the gamma ray energy in the first detector. (D.L.C.)

22396 RADIATION DETECTION APPARATUS. James A. Wall (to Controls for Radiation, Inc.). U. S. Patent 3,041,457. June 26, 1962.

An inexpensive and compact radiation detecting device is designed which gives immediate indication of harmful radiation. The device includes a solid-state detector, a current amplifier, a relaxation oscillator, and a loudspeaker for giving audible warning whose frequency is dependent on the radiation level. The device gives warning at radiation levels from <1 r/hr to >5000 r/hr without saturation and can be packaged in a volume smaller than a package of cigarettes. (D.L.C.)

Materials Testing

22397 (DC-59-6-20) PRESSURE TEST OF D101-L2 HEXAGONAL CYLINDERS. W. E. Greenwald (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). May 26, 1959. Contract AT(11-1)-171. 17p.

Two thin-walled hexagonal cylinders were subjected to internal pressure until they burst. Surface strains at the bent and welded edges of these specimens were measured throughout the tests. The relationships between internal pressures and the recorded strains are described. (auth)

22398 (DC-59-6-31) THE BENDING PROBLEM OF A SYMMETRICALLY LOADED CIRCULAR PLATE OF VARIABLE THICKNESS. H. A. Eagle (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). May 27, 1959. Contract AT(11-1)-171. 26p.

The problem of symmetrical bending of a circular plate of variable thickness was analyzed by a method of dividing the plate into a number of concentric ring segments of linear thickness variation. The derivation of equations for both the ring-type and solid segments, the method for combining the solutions for the individual segments into a compatible solution for a complete plate, and a discussion of the adaptability of the solution for a digital computer are presented. Due to the nature of the solution it is possible to obtain solutions for variable lateral loading in the radial direction, circumferential line loads, variable elastic properties, and arbitrary edge fixity. (auth)

22399 (PLASTEC-NOTE-1) THE APPLICATION OF NONDESTRUCTIVE TESTING TO PLASTICS. Alfred M. Anzalone (Picatinny Arsenal. Plastics Technical Evaluation Center, Dover, N. J.). July 1961. 42p. (PB-171810)

An annotated bibliography is presented on nondestructive testing techniques for plastics. Twenty-five references on the ultrasonic techniques and 16 references on the non-ultrasonic approaches are presented. Other related information not available in report form is briefly discussed. (auth)

GEOLOGY, MINERALOGY, AND METEOROLOGY

22400 (CLOR-10) WATER RADIOACTIVITY, POLAND 1960. R. Szepke, M. Bysiek, and D. Grzybowska (Poland. Biuro Pelnomocnika Rzadu do Spraw Wykorzystania Energii Jadrowej. Centralne Laboratorium Ochrony Radiologicznej, Warsaw). 1961. 52p.

Data on gross beta activity of 477 water samples collected in 1960 are reported, and data on 1715 water samples published by all Polish stations in the period 1957 to 1960 are summarized. Calculations show that only about 1% per year of the total annual radioactivity deposited in the Vistula River drainage area is removed by the river to the Baltic Sea. In 1960 the average radioactivity of fission products in waters on this area was found to be 17.3% of that of 1959. (auth)

22401 (HW-69571) GEOLOGY UNDERLYING HANFORD REACTOR AREAS. Donald J. Brown (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 1, 1962. Contract AT(45-1)-1350. 20p.

The latest concepts of the geology underlying the Hanford Reactor Areas are summarized. There are three distinct geologic units beneath the reactor areas: the Columbia River Basalt, the Ringold formation, and the Glaciofluviatile sediments. The basalt series forms the bedrock beneath the reactor areas and is generally compact, hard, and dense. The Ringold Formation overlies and is largely conformable to the basalt. This formation is an extensive lacustrine and fluviatile deposit of sand, silt, gravel, and clay. Overlying the Ringold formation to a maximum depth of 170 ft is a sedimentary deposit of fluviatile and glaciofluviatile outwash sands and gravels. The structure of the materials underlying the reactor areas reflects the deformation occurring essentially continuously for the last several million years. The contour of the water table in the region underlying the reactor areas reflects strongly the contact between the Ringold Formation and the Glaciofluviatile sediments. (auth)

22402 (JEN-101-SIG/I-1) RELACIONES GENÉTICO-ESTRUCTURALES DE ALGUNOS TIPOS DE MINERALIZACIONES URANÍFERAS ESPAÑOLAS. (Genetic-Structural Relations in Some Types of Spanish Uranium Deposits). M. Alia Medina (Spain. Junta de Energia Nuclear, Madrid). 1962. 18p.

On the Spanish hercynian areas there are different types of uraniferous deposits which may be classified in the following groups: high temperature magmatic deposits; low temperature veins; and supergenic deposits, generated by weathering of the former ones or by lixiviation of the intragranitic uranium. The deposits belonging to Group I are found in the hercynian geanticlinal; those of Groups II and III, chiefly in the eugeosyncline. The explanation for these genetic-structural relationships assumes that, in the geanticlinal, uranium would migrate from the dioritic magmas to form contact and high temperature deposits. In the eugeosyncline a large fraction of the uranium would migrate toward more differentiated granites in which it might partially remain or concentrate in the epithermal veins or by later tectonic actions. The Group III deposits are more frequent in the eugeosyncline due to the greater abundance of more differentiated intrusive rocks. (auth)

22403 (NP-11638) NATURAL RADIOACTIVITY IN GROUND WATER SUPPLIES IN MAINE AND NEW HAMPSHIRE. Final Report, October 26, 1959 to October 25, 1960. Werner N. Grune, Frederick B. Higgins, Benjamin M. Smith, and Joseph H. Mehaffey, Jr. (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Oct. 26, 1960. Contract SAph-73551. 77p.

Results are tabulated of a survey of natural radioactivity in ground water supplies in Maine and New Hampshire in 1959 and 1960. Sampling and analytical procedures are described that were developed to emphasize speed while preserving accuracy. A lightweight, compact, transistorized detection system for versatile uses was developed. Schematic diagrams and photographs are included. The system is designed to count two samples simultaneously and may be connected to a proportional counter converter for simultaneous counting of both α and β particles. The system may also be operated as a manual γ spectrometer after suitable calibration with radioactive sources. (C.H.)

22404 (RM-3005-PR) THE IRRELEVANCE OF THE GNOME SHOT TO DECOUPLING. A. Latter, R. Latter, and W. McMillan (RAND Corp., Santa Monica, Calif.). Jan. 1962. Contract AF49(638)-700. 4p. (AD-270861)

The Gnome shot — tamped in salt — has no relevance to the decoupling factor which, by definition, relates the seismic signal from a tamped shot in tuff to that from a cavity shot in salt. An explanation is given of how the misconception about Gnome arises. The best estimate of the decoupling factor is still 300. (auth)

22405 (RME-4511) RECONNAISSANCE FOR URANIUM IN THE CUZCO-AYAVIRI REGION, SOUTHERN PERU. Lawrence J. Brown and Francisco Cútolo L. (Division of Raw Materials, AEC and Peru. Junta de Control de Energia Atomica, Lima). Oct. 1957. 12p.

Geologic and radiometric investigations of the Cuzco-Ayaviri region in southern Peru were made in a search for geologic features or structures which might be favorable for the occurrence of uranium. Outcrops consist of Lower Paleozoic sedimentary and metamorphic rocks; Permian to Carboniferous volcanic flows, tuffs, breccia and agglomerate, together with sedimentary rocks; and Cretaceous and sedimentary rocks. Cretaceous to Tertiary igneous rocks are acidic intrusives and extrusive rhyolite, dacite and trachyte. Tertiary to Quaternary volcanic tuffs, breccias and agglomerates are also present. Although no anomalous radioactivity was observed, favorable geologic features for the occurrence of uranium were noted at two localities. (auth)

22406 (RME-4540(Rev.)) RECONNAISSANCE FOR URANIUM IN THE PUNTA ARENAS AREA, PROVINCE OF MAGALLANES, CHILE. Paul H. Knowles, William A. Bowes, Aido Moraga B., and Mario Serrano C. (Division of Raw Materials, AEC and Chile. Instituto de Investigaciones Geológicas, Santiago). Mar. 1962. 17p.

A reconnaissance of the Punta Arenas area in southern Chile was made to investigate the uranium potential of the sedimentary rocks of Jurassic to Tertiary age, many of which show traces of oil although only one sedimentary sequence is productive. No metallic or radioactive mineral deposits are known in this sedimentary section. No igneous rocks were examined, but a limited reconnaissance was made of the metamorphic rocks near the igneous rocks in the western zone of the sedimentary basin; where examined, no anomalous radioactivity was found in the vein-type

sulfide deposits. A complete collection of several thousand meters of drill cores and sludge samples from oil exploration work was examined for radioactivity; selected localities were visited; and favorable host rocks and structures were checked for radioactivity. No anomalous radioactivity was noted in the drill cuttings or in potentially favorable geologic settings for uranium. On the basis of present evidence, it seems probable that uraniferous solutions did not traverse the potentially favorable host rocks and structures in the area. (auth)

22407 (TEI-780) PRELIMINARY RESULTS OF A SURVEY FOR THICK HIGH-CALCIUM LIMESTONE DEPOSITS IN THE UNITED STATES. R. E. Davis, W. P. Williams, R. B. Johnson, and W. L. Emerick. Includes Section on: POSSIBLE ALASKAN SITES FOR NUCLEAR REACTION EXPERIMENT IN LIMESTONE. G. Donald Eberlein (Geological Survey, Washington, D. C.). Jan. 1961. 45p.

A preliminary study of limestone deposits in the continental U. S. and Alaska was made for the purpose of selecting deposits of sufficient size, relief, and purity in which to conduct an underground nuclear test. Of the many areas that received preliminary appraisal as potential sites, 10 in the continental U. S. and 6 in Alaska appear to offer possibilities of meeting the primary criteria of purity and thickness. Requirements of the areas and information on the areas themselves are listed. (P.C.H.)

22408 (TEI-814) INTERIM GEOLOGICAL INVESTIGATIONS IN THE U12b.08 TUNNEL, NEVADA TEST SITE, NYE COUNTY, NEVADA. W. L. Emerick and F. N. Houser (Geological Survey, Washington, D. C.). Mar. 1962. 38p.

The U12b.08 tunnel is a part of the U12b tunnel system, which was driven southwestward beneath Rainier Mesa in the northern part of the Nevada Test Site. The tunnel was driven in nonwelded vitric tuff of the Survey Butte Member of the Oak Spring Formation of Miocene(?) or younger age. Vertical and minimum cover over the end of the tunnel to the surface of Rainier Mesa is about 800 feet. The tuffs in the tunnel strike northwest to northeast and dip 5° to 14° SW to NW. The principal structural features of the tuffs are a major northwest-trending fault of steep dip with a downward displacement to the southwest of more than 15 feet and two west-trending synclines. The major fault exposes tuffs of the Survey Butte Member that are stratigraphically higher than any previously mapped in the tunnel system. Several other steeply dipping northwest- and northeast-trending faults of small displacement cut the tunnel. Joints are common and they trend dominantly either northeast or northwest with generally vertical to steep dips. The tuffs in this section of the Survey Butte Member are moderately well bedded to structureless fresh vitric tuffs that show cylical repetitions in sets of texture, structure, color, and composition. The chemical and physical properties of the tuffs in the U12b.08 tunnel are similar to other tuffs of the Oak Spring Formation from the Nevada Test Site. (auth)

22409 (TEI-818) GROUND WATER TEST WELL C, NEVADA TEST SITE, NYE COUNTY, NEVADA. A Summary of Lithologic Data, Aquifer Tests, and Well Construction. M. S. Garber and William Thordarson (Geological Survey, Washington, D. C.). 1962. 88p.

Ground-water test well C was drilled to a depth of 1,701 feet with rotary and cable-tool drilling equipment. It penetrated 215 feet of valley fill of Quaternary and Tertiary (?) age, 1,140 feet of tuff of Tertiary age, and 346 feet of limestone of Paleozoic age. The static water level is about 1,544 feet below the land surface, or 2,377 feet above sea level. Water occurs only in the limestone and is yielded chiefly from fractures. The well was pumped at rates of 60, 62, and 212 gallons per minute for protracted periods, and apparently could yield much more. The drawdown created by pumping was largely obscured by barometric-pressure and possibly by earth-tide effects, but probably was no more than 0.5 foot, and the specific capacity therefore may be about 450 gallons per minute per foot of drawdown. Water from test well C is of the sodium bicarbonate type with a relatively high percentage of calcium and sulfate. (auth)

22410 (TID-15817) RADIO-CAESIUM, -STRONTIUM AND -BARIUM IN EVERY RAIN AT LOWER HUTT, NEW ZEALAND (MAY 1959–SEPTEMBER 1961). Cover carries title: (THE DEPOSITION OF RADIO–STRONTIUM, –CAESIUM, AND –BARIUM IN EVERY RAIN AT GRACEFIELD, LOWER HUTT, NEW ZEALAND). Final Report. G. S. McNaughton and R. N. Woodward (New Zealand. Inst. of Nuclear Sciences, Lower Hutt). Oct. 1961. Contract AT(30-1)-2167. 57p. (INS-R-13)

Measurements of Sr^{90}, Cs^{137}, and Ba^{140} deposition at Lower Hutt, New Zealand (41°S) from Jan. 1959 to Sept. 1961 in individual rains or rain periods are reported. The rate of dry deposition collected on a wet surface was about 0.7 ± 0.3 μc of Sr^{90} per dry day calculated from about six separate dry spells of about a week. This rate was equivalent to about 9% of the total Sr^{90} deposited per year in the collector. The average of the monthly Cs^{137}/Sr^{90} ratios was 2.1 ± 0.3. There was no apparent variation of this ratio with time. This suggests that there has been little fractionation of Cs^{137} and Sr^{90} since their formation. A few positive Ba^{140} determinations were measured but the activities were in all cases too low for the nature of the activity to be confirmed by half-life measurements. The Sr^{90} deposition in the 12 month period Oct. 1960 to Sept. 1961 was 38% higher than in the previous 12 months. (P.C.H.)

22411 (TID-15914) NATURAL RADIOCARBON IN THE SUBSURFACE WATERS OF THE CARIBBEAN. Robert D. Gerard and Wallace S. Broecker (Columbia Univ., Palisades, N. Y. Lamont Geological Observatory). May 1962. Contract AT(30-1)-2663. 17p.

Presented at the 43rd Annual American Geophysical Union Meeting.

The natural radiocarbon concentration of 30 subsurface water samples from the Caribbean was measured, and the results were compared among the different basins and with previously reported Lamont samples from the nearby Atlantic. The basins of the northern Caribbean showed higher C^{14}/C^{12} ratios for waters below still depths than the basins to the south. North of the Jamaica ridge four samples below 1800 meters depth in the Cayman basin had an average ΔC^{14} value of –73 per mil. This is not significantly different from the value at the sill depth of the Windward Passage through which replenishment takes place. South of the Jamaica ridge five samples from below sill depths in the Colombia basin averaged about 20 per mil lower C^{14}/C^{12} ratio than the Cayman and the Atlantic water at sill depth outside the Anegada-Virgin Passage through which deep water renewal takes place. These results indicated a slower circulation and longer residence time for the deeper water of the Venezuela and Colombia basins than the Cayman and Yucatan basins to the north. (auth)

22412 (AEC-tr-5119) CONTENT OF INERT GASES IN THE SIKHOTE-ALIN IRON METEORITE. A. P. Vinogradov, I. K. Sadoroshny, and K. P. Florenski. Translated by Marvin W. Rowe and Gretchen R. Riese (Los Alamos Scientific Lab., N. Mex.) from Chem. Erde, 19: 275-85(1958). 15p.

The content and isotopic composition of the inert gases separated from 3 individual meteorites of the Sikhote-Alin shower, which fell as a great number of individual meteorites and their fragments on Feb. 12, 1947, were studied. An attempt was also made to determine the position of He, Ne, and Ar isotopes in the original meteorite before its entrance into the atmosphere, and to estimate its original mass and age. The concept of a relation between the meteorite dimensions and the character of the piezoglypts on its surface was established. In two meteorites, a decrease of the helium and argon content, as well as a change of the isotopic ratio of He^3/He^4 with the distance from the surface to the opposite side, was seen clearly with large piezoglypts. In the case of a minimum helium content for a depth sample piece, an age of 50×10^6 was obtained, and in the case of a maximum helium content for a surface sample piece and age of 700×10^6 years was obtained. However, these ages only indicate the time which has elapsed since the time of its last solidification. (P.C.H.)

22413 (CEA-tr-R-1494) CONTRIBUTIONS A LA MINERALOGIE ET LA CRISTALLOCHIMIE DES URANINITES DE LA CARELIE DU NORD. (Contributions to the Mineralogy and Crystallochemistry of Uraninites in North Karelia, [S.S.R.]). V. A. Leonova. Translated into French from Zapiski Vsesoyuz. Mineral. Obshchestva, 88: 21-38(1959). 45p.

In spite of much information on the nature of uraninites in North Karelia, many important questions relative to their mineralogic nature remain unresolved. Among them are the differences in chemical composition of various morphogenetic types, the specificity of oxidation processes and their effect, and the effect on structure of radioactive lead and the substances isomorphic with Th and with rare earths. These problems are considered. The data obtained on the mineralogy, chemical composition, and structure of uraninites of the pegmatites filons permit the following conclusions to be drawn. A successive decrease in the concentration of Th and rare earths was observed for the morphological series of the uraninites. It was found that there exists a clearly determined ratio between the parameter of the elementary cells of the uraninites and its content of Th, rare earths, and radioactive lead on one hand and its degree of oxidation on the other hand. Oxidation is the final result of several opposing processes. The coefficient of release of uranium in the uraninites oscillates between the limits 0.5 to 15.8%. From a consideration of the isomorphic substitutions in the uraninites, of the presence of radiogenic lead, and uranium oxidation processes accompanied by a partial expulsion of the uranium, it is concluded that the most rational method for the chemical analyses of uraninites is their reconversion into crystallochemical formulas with a constant concentration in oxygen anions. (J.S.R.)

22414 INVESTIGATION OF THE RADIOACTIVE FALLOUT AND ACTIVITY IN THE AIR. [PART] VII. W. Gerlach and K. Stierstadt (Universität, Munich). Atomkernenergie, 7: 179-84(May 1962). (In German)

The results of fall-out activity measurements during 1960 and 1961 are reported. The level of average β activity in these two years was about 0.7×10^{-10} c/m^2 per day and about 3×10^{-10} c per gram of residue. During some weeks after the 4 French Sahara tests and after the Soviet test series in September/October 1961 the activity was increased by a factor 10 to 100 over the normal value, but did not reach the peak values of 1957, which were still some 100 or 1000 times higher than the 1960/61 maximum values. The activity of the storage device ("Sammler") was 2813×10^{-10} c/m^2 on the 31st of December 1961, 53% of this activity had an age of more than three years. The investigation of the natural-activity distribution on the aerosol spectrum was continued, the conditions of investigation much improved. A quantitative extension of the experiments of J. Elster and H. Geitel results in a method for measuring the distribution of activity carriers on the aerosol size-spectrum. Furthermore a relation between aerosol concentration and addition of radon decay products could be derived. The artificial loading of natural occurring aerosol with thoron decay products enables measurements to be made of the size and charge distribution of the activity carriers in a wide mobility range. The results are in good agreement with theory. (auth)

22415 TECTONICS, HYDROTHERMAL ZONING AND URANIUM IN THE CENTRAL ANDES. John W. Gabelman. Bol. Soc. Geol. Peru, 36: 67-101(1961). (In English)

The middle segment of the Andean Cordillera trends north-northwest through central and northern Peru. The geology and hydrothermal zoning of the region are described. The possibilities of uranium deposits are evaluated. (C.H.)

22416 THE GAMMA-FIELD INTENSITY OVER THE SURFACE OF THE SEA. A. F. Fedorov and G. V. Samokin. Doklady Akad. Nauk S.S.S.R., 143: 101-3(Mar. 1, 1962). (In Russian)

Gamma-ray measurements were carried out on the Barents Sea 1) on the open sea 2) near the shore, and 3) near bays, coves and inlets. The measurements were taken continuously from a ship. The γ counters were set at a constant height of 11 meters from the surface of the water. The counters were standardized with radium sources of known strength. The gamma readings on the open sea (50 to 100 miles) and near the shore (2 to 6 miles) were fairly constant ($P_\gamma \approx 2.5$). The gamma readings in the bays and inlets were higher on the average ($P_\gamma = 3$ to 4). Higher readings were obtained on the open sea right after a rainfall, but the readings returned to normal in a short time. (TTT)

22417 THE ECONOMIC GEOLOGY OF COLUMBIUM (NIOBIUM) AND OF TANTALUM. Nicolas De Kun (Columbia Univ., New York). Econ. Geol., 57: 377-404(May 1962).

With the development of carbonatite deposits, the resources of niobium have been increased to rank in importance with the major metals. Tantalum, the valuable twin element, still however, remains scarce. The two metals have a remarkable range of occurrence; carbonatites, placers, pegmatite, granites, basic alkaline rocks. In most of these occurrences the twin metals are part of a paragenesis that includes RE, Zr, Th, Sn (though only as a trace in carbonatites); W, Li, Be (only in pegmatites); Ti, Fe, P (not in granites), Ba, Sr, Mn, Fe, Mg. Niobium and tantalum are already disseminated in the earliest magmatic stages. The main concentrations of the earth acids are related to late processes of differentiation and replacement. However, the most valuable concentrations occur in products of alteration. The limit of tropical weathering often divides economic deposits from mere occurrences. The structural and zoneographic control of the mineralization is distinct. The majority of niobium and tantalum deposits are restricted to specific belts in Africa and South America. (auth)

22418 GEOLOGY AND ISOTOPIC STUDIES OF SICILIAN SULFUR DEPOSITS. G. Dessau, M. L. Jensen, and N. Nakai (Yale Univ., New Haven and Universita, Pisa, Italy). Econ. Geol., 57: 410-38(May 1962).

Stable isotopic studies of carbon and sulfur in correlation with geologic information have provided substantial evidence for a biogenic origin for native sulfur in salt domes. Similar studies on the Sicilian sulfur deposits indicate a biogenic syngenetic origin. Sulfur in Sicily occurs in a lagoonal evaporitic sequence of formations, known as the Gypsum-Sulfur series of late Miocene age. The series, begins with the Diatomite formation that is overlain by the Basal limestone. Commercial quantities of sulfur occur in the next youngest formation known as the Sulfur limestone, the limestone of which is composed of white granular calcite. Alternating above the Sulfur limestone are the sulfur-barren Gypsum Beds formation and the Globigerina marl. The δS^{34} composition of the native sulfur in the sulfur limestone roughly varies between +10 to −10 permil, in contrast to differences between +20 to +30 permil for the sulfur in gypsum and anhydrite from which it is inferred the sulfur has been derived. These differences of a few permil to more than 20 permil are typical isotopic fractionations obtained during the reduction of sulfate to hydrogen sulfide by anaerobic bacteria. It is inferred that energy for the bacterial reduction was most likely provided by organic material that was oxidized by the bacteria to carbon dioxide which then reacted with calcium ions, made available by the reduced sulfate, to form calcite. This biological derivation of carbon dioxide, resulting in calcite in the Sulfur limestone, is suggested by δC^{13} variations between −20 to −30 permit for this formation, in contrast to typical δC^{13} compositions of about −5 permil for carbonates in the other sulfur-barren formations. The almost complete lack of iron in the sediments that formed the sulfur limestone explains the lack of ferrous sulfide. Instead, it is inferred that the hydrogen sulfide was oxidized to native sulfur, in a suitable Eh environment having a limited supply of oxygen, by the expected exothermic reaction. It is, therefore, theorized that the Sicilian sedimentary sulfur deposits have a biogenic syngenetic origin. (auth)

22419 URANINITE-SCHEELITE PLACERS OF THE RIVER INDUS. C. F. Davidson (Univ. of St. Andrews, Scotland). Econ. Geol., 57: 456-7(May 1962).

Preliminary analysis of some 500 panned samples collected from an area extending for 400 miles up the Indus River into the Karakoram region, shows that scheelite, and probably uraninite also, is present in the alluvials of many side valleys. No evidence was found of long-distance alluvial transport of these minerals. (C.H.)

22420 OXYGEN ISOTOPIC COMPOSITION OF FOGS AND RAINS FROM THE NORTH ATLANTIC. R. Gonfiantini and A. Longinelli (Lab. of Nuclear Geology, Pisa, Italy). Experientia, 18: 222-3(1962). (In English)

Rain and fog samples were collected in the North Western Atlantic ocean during the months of May and June 1961. The oxygen isotopic compositions were measured by mass spectrometry. The results, presented in table form, are expressed in terms of difference per mil of the ratio O^{18}/O^{16} between the sample and the "mean ocean water" standard. It was concluded that, during the period in which samples were collected, fog was very likely formed by atmospheric water vapor in equilibrium with oceanic water. (M.C.G.)

22421 RADIOACTIVITY OF WATER IN OPEN WATER BASINS. V. M. Kupriyanova and E. S. Romanova. Gigiena i Sanit., 27: No. 3, 14-16(1962).

Data are presented on radioactivity of water in 123 open water basins of the RSFSR. The results of radiometric measurements of 368 samples of water and 177 various biological substrata indicate that the radioactivity level of water from water basins in different regions of the RSFSR fluctuates, in the main, from $1.0-10^{-12}$ to $16.9-10^{-12}$ s/l and is well below the maximum permissible dose. By way of exception, the radioactivity of water basins in Komi ASSR was higher. This region belongs to a group of regions with a high natural radioactivity. (Pub. Health Eng. Abstr.)

22422 ON DETERMINATION OF RaC′, ThC″, AND K^{40} IN UNIFORM GRANITOIDS BY MEANS OF γ RADIATION. N. D. Balyasnyi, R. M. Kogan, O. S. Renne, and Sh. D. Fridman (Inst. of Applied Geophysics, Academy of Sciences, USSR). Izvest. Akad. Nauk S.S.S.R., Ser. Geofiz., No. 5, 664-76(May 1962). (In Russian)

A scintillation spectrometer was used for measuring γ spectra on the surfaces of uniform biotite granites, and the concentrations of RaC′, ThC″, and K^{40} were determined. (R.V.J.)

22423 RADIOCARBON. Richard Foster Flint and Edward S. Deevey, eds. (Yale Univ., New Haven). Radiocarbon, 4: 1-266(1962).

Dates and activity measurements obtained during 1961 by C^{14} counting of geologic and archaeological samples are presented. Dates from some earlier measurements are included for some samples. Counting procedures are described briefly for some of the measurements. All dates are based on the Libby value, 5570 ± 30 years as the half life of C^{14}. A.D. 1950 is accepted as the standard reference year for dates. (C.H.)

22424 STRATOSPHERIC RESIDENCE TIME OF STRONTIUM-90. P. K. Kuroda, H. L. Hodges, L. M. Fry, and H. E. Moore (Univ. of Arkansas, Fayetteville). Science, 137: 15-17(July 6, 1962).

An over-all average stratospheric residence time for Sr^{90} of 0.7 ± 0.1 year was observed during the period of 1958 through 1960. Measurements were made of the Sr^{90} concentrations in the entire series of rainfalls that occurred at Fayetteville, Arkansas, during this period. (C.H.)

22425 INVESTIGATIONS ON THE STRUCTURE OF FISSION PRODUCT CLOUDS. H. Mueh and A. Sittkus (Max-Planck-Institut für Kernphysik, Heidelberg, Ger.). Z. Naturforsch., 17a: 235-8(Mar. 1962). (In German)

After the cessation of atomic bomb tests in October 1958, samples of fission products were collected from the air and investigated by autoradiographic methods. The blackening was measured and the frequency distribution of the particles was determined over the range of 2×10^{-12} down to 0.5×10^{-14} c. In relation to the total activity of fission products the number of particles containing 2×10^{-12} c decreased quickly, while that of particles smaller than 10^{-13} c became constant after a rapid initial drop. (auth)

22426 THE ISOTOPIC RATIO Sr^{87}/Sr^{86} OF STRONTIUM SAMPLES FROM LIMESTONES. W. Urbach, W. Ackermann, H. Ewald, and R. Ludwig (Technische Hochschule, Munich). Z. Naturforsch., 17a: 273(Mar. 1962). (In German)

Additional measurements of the isotopic ratio Sr^{87}/Sr^{86} in samples of limestone and sea water were carried out with improved accuracy. The mass spectrometer used has a resolution of approximately 250 and is provided with a thermal three-thread ion source and a multiplier. The experimental conditions used to obtain the improved accuracy are described. The results are tabulated. (J.S.R.)

HEALTH AND SAFETY

22427 (AEEW-M-201) SPECIFICATION FOR A STANDARD RADIOLOGICAL EMERGENCY TRAINING EXERCISE AT A.E.E., WINFRITH. EXERCISE TEACHER–RADIATION. J. F. Croft, D. C. Fraser, and K. E. G. Perry (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Establishment, Winfrith, Dorset, England). Jan. 1962. 31p.

A radiation exercise is described that is carried out regularly at A.E.E. Winfrith as an aid to the radiological emergency training of professional staff of various disciplines. It is designed especially for those staff who might be required to accept certain responsibilities under emergency conditions, but who do not themselves normally work intimately with sources of radiation. (auth)

22428 (CNI-58) A RESEARCH PROGRAM FOR THE STUDY OF RADIOACTIVITY IN MOLLUSCS AS A POSSIBLE INDEX TO THE CONTAMINATION OF A LAKE. O. Ravera and M. Merlini (Italy. Comitato Nazionale per l'Energia Nucleare. Centro di Studi Nucleari, Ispra). Sept. 1960. 13p.

Viviparus ater, the largest Prosobranch (Mollusks) living in fresh water of Italy, was chosen as a possible index for contamination from radioactive wastes. Viviparus has the advantage of a wide distribution and of a close dependence on the sediments and the water of the basin in which it lives. The mollusks were collected in the Maggiore, Pusiano, Varese, Alserio, Annone, and Comabbio lakes. The characteristics of these lakes are tabulated. The radioactivity of the animals has to be ascribed only to natural radioactivity plus the activity from fall-out, because up to now no radioactive wastes have been discharged in these lakes. The values of the beta activity measured in the shell and in the soft parts are tabulated. Differences are attributed to the differences of activity in the examined lakes and the very different metabolic rates of the shell and of the soft parts. (auth)

22429 (K-1529) PREPARATION OF LITHIUM FLUORIDE SHIELDS FOR PHOSPHATE GLASS RODS IN PERSONNEL FILM BADGES. E. M. Foley and D. E. White (Oak Ridge Gaseous Diffusion Plant, Tenn.). June 19, 1962. Contract W-7405-eng-26. 6p.

A method is described for preparation of lithium fluoride shields for phosphate glass rods in personnel film badges. The method consists of hot pressure bonding of lithium fluoride powder with FEP-fluorocarbon resin in a properly shaped opposing ram die. (auth)

22430 (NP-11379) SURVEILLANCE MEDICALE DES TRAVAILLEURS EXPOSES AUX RADIATIONS IONISANTES. ETUDE STATISTIQUE D'HEMOGRAMMES DU PERSONNEL D'UNE CENTRALE NUCLEAIRE AVANT LA DIVERGENCE. (Medical Inspection of Workers Exposed to Ionizing Radiations. Statistical Study of Hemograms of Personnel of a Nuclear Power Station before Divergence). M. Delpla, R. Nussbaum, and P. Funel (France. Electricité de France, Paris). [1961]. 21p.

[For presentation] at Symposium Organisé par Euratom, Stresa, May 2-5, 1961.

A statistical study of hemograms shows that emotion caused by the hematological sampling distorts the results on all varieties of blood cells: considerably for polynuclear neutrophiles when they cause the augmentation by a large factor, and for lymphocytes on which it causes a slight decrease. The emotional factor should be considered in the interpretation of all individual homograms for systematic control or after accidents. This factor should be considered during the establishments of norms. (tr-auth)

22431 (NP-11704) THE RADIOACTIVITY IN AIR AND PRECIPITATION DURING AUTUMN 1961. G. Lindblom and K. Edvarson (Sweden. Försvarets Forskningsanstalt, Stockholm). Dec. 1961. 16p.

Data are presented graphically on total radioactivity in samples of air and precipitation collected in Sweden from Sept. through Dec. 1961. A marked increase in radioactivity levels during the period is attributed to the U.S.S.R. weapons tests in Siberia and the Barent's Sea area. (C.H.)

22432 (NYO-4814) EFFECT OF PULSATING AIR FLOW ON FIBER FILTER EFFICIENCY. Harry S. Jordan and Leslie Silverman (Harvard Univ., Boston. School of Public Health). Dec. 15, 1961. Contract AT(30-1)-841. 74p.

Sub-micron particulate removal efficiency was determined for a fiberglass filter media (13.5 μ fiber) at several constant aerosol stream velocities and then the results were compared to those found for the same filter subjected to a sine wave form pulsating airflow (simulating human respiratory airflow pattern) at the same mean stream velocities. Experimental results indicated that filter efficiency, under conditions of pulsating flow at a given mean velocity, can not be predicted from efficiency values obtained under conditions of steady flow. Collection efficiencies under conditions of pulsating flow were higher at low mean velocities and lower at high mean velocities than efficiency obtained under conditions of steady flow at corresponding velocities. Theoretical considerations were examined and three factors postulated for the observed difference; a basic change in the flow pattern through the filter, a change in the number of effective impactions, and the removal of deposited particles. Respiratory protective equipment would represent the principal application of filtration under conditions of pulsating flow. Another aspect of interest, however, is the possibility that these studies indicate a potential application to pulsating flow from fans which could affect in-line filter devices. It was concluded that in the range of mean velocities expected in the use of filter masks the effect of pulsating flow would be to increase the collection efficiency of the filter element. A simple readily constructed spinning disc homogeneous aerosol generation is described in detail. (auth)

22433 (TID-7632) RADIOACTIVE FALLOUT FROM NUCLEAR WEAPONS TESTS. Proceedings of a Conference Held in Germantown, Maryland, November 15-17, 1961. Alfred W. Klement, Jr., ed. (Division of Biology and Medicine. Fallout Studies Branch, AEC). Feb. 1962. 546p.

Thirty papers are presented reviewing AEC research projects related to fall-out from weapons tests. Reviews of specific related programs by representatives from Canada and the UK are also included. The scope of the conference includes characteristics of fall-out, atmospheric factors affecting deposition, distribution in the environment, and distribution in the food chain and man. Separate abstracts have been prepared for each paper. (C.H.)

22434 (TID-7632(p.4-24)) NEVADA TEST SITE FALL-OUT: SOME CHARACTERISTICS, ITS APPARENT ENVIRONMENTAL EQUILIBRIUM AND BIOLOGICAL AVAILABILITY. Kermit H. Larson, Howard A. Hawthorne, and John H. Olafson (California. Univ., Los Angeles).

Fall-out from the detonation of test devices at the Nevada Test Site is governed by many complex variables such as energy yield and type of device, wind structure, support used for the device, nature of the ground surface, contact of the fireball with ground surface, and mass of inert material surrounding the device. Findings are summarized on the distribution and characteristics of fall-out from detonations of tower-mounted devices and from balloon-mounted or air-dropped devices having less than 75 kt yield. The environmental equilibrium and biological availability of fission products are considered with emphasis on Sr^{90}. Results of biological studies indicate that biological availability of Sr^{90} is much greater at some early time after fall-out and that mechanisms for the reduction of potentially available Sr^{90} exist in the environment, regardless of apparently persistent Sr^{90} soil levels. (C.H.)

22435 (TID-7632(p.60-8)) GAMMA-RAY DOSE FROM SHORT-LIVED FISSION PRODUCTS. Phillip F. Gustafson and S. S. Brar (Argonne National Lab., Ill.).

Methods are discussed for calculating the external γ dose due to the deposition of short-lived fall-out fission products. Meteorological factors contributing to the spring maximum in Cs^{137} concentration in surface air observed annually since 1954 are discussed. By comparing the Cs^{137} concentration in air during successive maxima or minima it is possible to determine a mean stratospheric residence time and variation in residence time as a function of geographic latitude and the altitude of detonation or the altitude to which debris was carried initially. Data are tabulated on the ratio of dose from short-lived fission products to that from Cs^{137} as a function of mean residence time. It is concluded that the methods discussed provide an approximate estimate of exposure. (C.H.)

22436 (TID-7632(p.25-46)) FRACTIONATION IN SURFACE BURSTS. Edward C. Freiling (Naval Radiological Defense Lab., San Francisco).

A description is presented of a combination of A. D. Anderson's Dynamic Fallout Model (NRDL-D Model) with C. F. Miller's thermodynamic model of fractionation which is used to account for fractionation in fall-out predictions. Weaknesses of the method are pointed out. Data required for testing the model, both from laboratory experiments and nuclear detonations, and for achieving more meaningful documentation of future nuclear bursts, are discussed. (auth)

22437 (TID-7632(p.47-59)) PARTICLE FORMATION AND FRACTIONATION IN AIR BURSTS. Edward C. Freiling (Naval Radiological Defense Lab., San Francisco).

The relation of fall-out formation processes in air bursts to processes occurring in other types of bursts is discussed. Results obtained to date on testing available particle formation theories and means of extending these theories to include fractionation are described. A brief summary of available results of fractionation correlations on air burst debris is given and data requirements from future detonations are presented. (auth)

22438 (TID-7632(p.74-97)) RAIN SCAVENGING STUDIES. A. Nelson Dingle (Michigan. Univ., Ann Arbor).

Results are reported from a series of studies on the determination and quantification of the processes by which rain cleanses the atmosphere. Emphasis is placed on rain scavenging of radioactive particulates. The relationship between scavenging and rain generation is considered. Instruments are described that were designed to provide observational data. Rain sampling procedures and theoretical developments designed to model the physical processes of scavenging in quantitative terms are described. Analyses are included for a series of storms in the vicinity of Willow Run, Mich., during Sept. 1961. (C.H.)

22439 (TID-7632(p.98-119)) THE INTERACTION BETWEEN RADIOACTIVE AND NON-RADIOACTIVE PARTICLES IN THE STRATOSPHERE. James E. Manson (Air Force Cambridge Research Labs., Bedford, Mass.).

The relationship between particles that carry nuclear debris and non-radioactive particles occurring naturally in the stratosphere is considered. Interaction mechanisms and the role of the sulfur cycle of the stratosphere in removing long-lived small particulates from this region of the atmosphere are discussed. Data are tabulated on the composition of particles collected at various altitudes with the aid of filters and impactors. It is concluded that a positive correlation exists between radioactive and non-radioactive stratospheric particulates. (C.H.)

22440 (TID-7632(p.122-35)) A COMPARISON OF FALLOUT MODEL PREDICTIONS WITH A CONSIDERATION OF WIND EFFECTS. Gilbert J. Ferber and Jerome L. Heffter (Weather Bureau, Washington, D. C.).

Limitations in the construction of fall-out models imposed by the scarcity of available fall-out data are discussed. The effects of wind shear and speed and shielding factors on the accuracy of fall-out predictions are considered. It is pointed out that conclusions drawn from nuclear test data must be applied with caution to burst conditions likely to be encountered in a nuclear attack. Fall-out predictions based on several models currently in use are compared. It is shown that the various models give very different results. It is pointed out that wind conditions can drastically affect the dose-distance relationship as well as the orientation and shape of the pattern. These differences may be quite important in the critical range from about 200 to 700 r where relatively small changes in dose result in large changes in the fatality estimates. On a national scale, the additive effects of hundreds of nuclear bursts during a nuclear attack would further complicate the accuracy of fall-out predictions. (C.H.)

22441 (TID-7632(p.136-44)) THE EARLY TRANSPORT OF NUCLEAR DEBRIS. Phillip W. Allen, Frank D. Cluff, and Isaac van der Hoven (Weather Bureau, Las Vegas, Nev.).

Recent improvements in the prediction of close-in fall-out are reviewed. It is pointed out that many of the eddy motions in the atmosphere that affect fall-out patterns must be considered random in the sense that their cause, source, history, and dimensions are obscure. The need is stressed for the development of a high-speed weather data handling and computing system for mesoscale applications as part of a large-scale meteorological forecasting system. Applications are suggested in meteorological support of projects involving control of toxic air pollution whether from fall-out, nuclear engine exhaust gases, toxic chemical rocket exhausts, or industrial waste. Features of the proposed mesoscale unit are outlined. (C.H.)

22442 (TID-7632(p.149-69)) AN INTERPRETATION OF GLOBAL FALLOUT. L. Machta, R. J. List, and K. Telegadas (Weather Bureau, Washington, D. C.).

Data are presented on the world-wide inventory of Sr^{90} prior to the U.S.S.R. 1961 nuclear tests and the geographical and temporal distribution of stratospheric fall-out dur-

ing the period 1959 to 1961. A prediction is made of future fall-out resulting from the U.S.S.R. 1961 tests. (C.H.)

22443 (TID-7632(p.170-87)) PRELIMINARY RESULTS ON THE SIZE AND VERTICAL DISTRIBUTIONS OF RESIDUAL NUCLEAR DEBRIS IN THE STRATOSPHERE. Peter J. Drevinsky and Edward A. Martell (Air Force Cambridge Research Labs., Bedford, Mass.).

Results are reported from an investigation of the physical properties of stratospheric aerosols as a function of altitude. Samples were collected with a large volume balloon-borne impactor unit having a capacity of 1000 ambient cu ft of air per sample and with a larger balloon-borne air filter sampler employing a 10 ft^2 polystyrene microfiber filter in a cylindrical configuration. Data are tabulated on the total β activity, percent of β activity, and Ce^{144}, Sr^{90}, Rh^{102}, and Pb^{210} activity of the samples. Particle size measurements showed that residual contamination at levels of 90,000 to 100,000 ft and above resides in particles below 0.02 μ radius. The size distribution of radioactivity in the lower stratosphere appears to correspond with the peak in the number distribution and the lower end of the mass distribution of the natural sulfate aerosol. Results indicate that the finely-divided radioactive aerosol mixes down from higher levels of the stratosphere and either seeds the formation, or becomes attached to, sulfate aerosol particles. The experimental results clearly indicate that sedimentation plays a relatively minor role in the vertical transport of residual contamination, both within the lower stratosphere and across the tropopause. Tentative results are included from vertical profile measurements in the equatorial stratosphere. The collection efficiency of polystyrene filters and IPC paper for submicron particles is discussed. It was concluded that polystyrene microfiber filters provide high efficiency and have the additional advantage of low chemical and radiochemical impurity. (C.H.)

22444 (TID-7632(p.188-203)) ATMOSPHERIC RADIOACTIVITY PATTERNS ALONG THE 80th MERIDIAN (WEST) 1959-1961. Luther B. Lockhart, Jr., Robert L. Patterson, Jr., Allen W. Saunders, Jr., and Robert W. Black (Naval Research Lab., Washington, D. C.).

Results are presented from a study of fission products and natural Pb^{210} in the air at ground level along the 80th meridian during the period 1959 through 1960. Seasonal variations in the quantities of fall-out materials in the air of both hemispheres are documented. Changes were noted in the relative concentrations of Ce^{144} and Sr^{90} during 1960. Lead^{210} concentrations in the air along the 80th meridian showed a latitudinal distribution similar to that of fission products but with no systematic increase with altitude. The presence of Pb^{210} at the higher altitudes is attributed to the vertical mixing of air masses containing Pb^{210} and/or Rn rather than gaseous diffusion of the latter material. Data are tabulated on gross β activity in the air, gross fission products, concentration of Sr^{90}, Ce^{144}, and Pb^{210}, and contribution of the French test of Feb. 1960 to changes in the concentration of fission product radioactivity and Sr^{90} at various sampling stations. (C.H.)

22445 (TID-7632(p.204-9)) GENERAL CIRCULATION OF THE STRATOSPHERE. Arnold A. Barnes, Jr. (Massachusetts Inst. of Tech., Cambridge).

Using data from 212 stations over the Northern Hemisphere, the meridional circulation at 50 mb for the period July through December 1957 was obtained for the lower stratosphere. The mean meridional circulation was also computed from the adiabatic assumption. The mean adiabatic and diabatic motions have the same magnitures but generally oppose each other. It is concluded that both the mean circulation and the eddies must be considered in any model of long-term stratospheric transport of radioactive material. (auth)

22446 (TID-7632(p.210-22)) THE TRANSPORT OF OZONE AND RADIOACTIVITY IN THE ATMOSPHERE; IMPLICATIONS OF RECENT STRATOSPHERIC CIRCULATION FINDINGS. Reginald E. Newell (Massachusetts Inst. of Tech., Cambridge. Dept. of Meteorology).

Ozone has a stratospheric source, is subject to stratospheric-tropospheric exchange, and has a maximum concentration in both the middle latitude stratosphere and the lower troposphere in late winter or spring. Ozone transport calculations are presented in which both eddy diffusion and mean motions are taken into account. The relationship between ozone concentrations and concentrations of fission products from high-yield nuclear weapons tests is discussed. Meteorological and seasonal factors and the effect of tropospheric-stratospheric mass exchange are considered for various latitudes. It is concluded that both quasi-horizontal eddy mixing and mean meridional motions must be taken into account in attempts to explain the movement of trace substances in the stratosphere. The ozone data indicate more quasi-horizontal eddy mixing in the winter and this provides a possible explanation for the increased concentration of ozone in the middle and higher latitude lower stratosphere which is followed by increases in the tropospheric concentrations of both ozone and fission products. The ozone flux data also indicate that the pattern of events varies from year to year. (C.H.)

22447 (TID-7632(p.223-41)) GEOCHEMICAL STUDIES ON THE STRATOSPHERIC FALLOUT. P. K. Kuroda, H. L. Hodges, M. P. Menon, Tin Mo, Joe Nix, L. M. Fry, and H. E. Moore (Arkansas. Univ., Fayetteville).

Brief summaries are presented from a series of geochemical studies on stratospheric fall-out. A time interval of 10^8 years between the cessation of nucleosynthesis and the formation of the earth was calculated, assuming that the extinct Pu^{244} was mainly responsible for the production of excess xenon isotopes in the earth's atmosphere. Other sources of atmospheric xenon are discussed. Experimental results support the Brewer-Dobson model of global circulation of air masses. A pronounced peak of fall-out rate during the spring months was attributed to an increase in the rate of material transfer from the stratosphere to the troposphere, caused by the sinking of cold air masses formed above the winter pole during the late winter months. The effects of seasonal and global movements of stratospheric air masses on spring peaks of Sr^{90} fall-out and the stratospheric residence time of Sr^{90} and Ce^{144} are discussed. Factors contributing to a sharp increase in the Sr^{89}/Sr^{90} ratio in rain at Fayetteville, Arkansas, after the French nuclear detonations of Feb. and April 1960 are discussed. (C.H.)

22448 (TID-7632(p.242-55)) METEOROLOGICAL INFLUENCES ON Sr^{90} FALLOUT CONCENTRATIONS IN PRECIPITATION. PART I. LARGE-SCALE UPLIFT. Paul Kruger, Leonard P. Salter, and Charles L. Hosler (Nuclear Science and Engineering Corp., Pittsburgh).

Analysis of 3 winter rainstorms resulting from large-scale uplift of air in which the generating level and the precipitation mechanism were essentially constant showed that the ground-level Sr^{90} concentration in the precipitation was determined by the descent experience of the precipitation in falling from the generating cloud to the ground. The descent experience is expressed in terms of the height of the ceiling, which is an index of the humidity profile and depth

of the lower layers of air. These parameters affect the rate of evaporation or growth of precipitation elements, and thus the final concentration of Sr^{90} reaching the ground. Work is reported in progress to study the influence of convective showers and orographic systems on Sr^{90} fall-out concentration. (C.H.)

22449 (TID-7632(p.256-70)) RADIONUCLIDES IN PRECIPITATION. Philip W. Krey and Alan Walton (Isotopes, Inc., Westwood, N. J.).

Nuclide ratios in precipitation can be used to identify the source of radioactive fall-out and to approximate the contribution of certain test series to the total Sr^{90} fall-out at specific times. Analysis of rainfall data from 1958 through 1961 suggests that the debris from nuclear detonations initially has a relatively rapid movement within the stratosphere to yield a metastable distribution which subsequently changes at a much slower rate. The contribution of meteorological data to interpretation of fall-out measurements is discussed. (C.H.)

22450 (TID-7632(p.271-8)) MEASURED AND PREDICTED CONTRIBUTIONS FROM FALLOUT TO ENVIRONMENTAL RADIATION LEVELS. William R. Collins, Jr. (New York Operations Office. Health and Safety Lab., AEC).

Concentrations of Sr^{89} and Sr^{90} in fall-out collected in New York City have been measured since 1954. Determinations of Cs^{137}, W^{185}, Zr^{95}, Ru^{106}, Ce^{144}, and Y^{91} were also performed whenever possible on samples collected at the same site. These data have proven to be a useful means of estimating the contributions made by fall-out to environmental radiation levels and as a means of tracing the atmospheric history of fall-out from different origins. They also serve as a basis for predicting what effects the Russian 1961 test series will have on future fall-out levels. (C.H.)

22451 (TID-7632(p.287-98)) THE RELATIONSHIP BETWEEN RAINFALL AND STRONTIUM-90 DEPOSITION IN CLALLAM COUNTY, WASHINGTON. Edward P. Hardy, Jr. (New York Operations Office. Health and Safety Lab., AEC) and Lyle T. Alexander (Department of Agriculture. Soil Survey Labs., Beltsville, Md.).

An analysis was made of the relationship between rainfall and Sr^{90} deposition. Samples were collected at several sites in Clallam County, Wash., where the yearly amount of rainfall varies from about 15 in. to 110 in. annually at the sites selected and each sampling site has shown only a slight variation in annual rainfall since 1939. Results of the study showed that there is a remarkably good linear relationship between Sr^{90} fall-out and amount of rainfall, if it is assumed that all the Sr^{90} activity per unit volume of rain decreases with increasing rainfall. Strong evidence was obtained that a substantial amount of the Sr^{90} deposited was not associated with precipitation. When the amount of Sr^{90} brought down by rainfall alone was calculated by subtracting the dry fall-out contribution from the total measured, the Sr^{90} concentration in rain was shown to be independent of the amount of rainfall. (C.H.)

22452 (TID-7632(p.299-305)) RUNOFF OF STRONTIUM-90 FROM AGRICULTURAL LAND SURFACES. Maurice H. Frere and Ronald G. Menzel (Department of Agriculture. Soil and Water Conservation Research Div., Beltsville, Md.).

The movement of Sr^{90} in surface runoff and soil erosion from agricultural land surfaces was studied. Measurements were made on the soil in sloping areas, on runoff from small plots, and on river waters. Data are tabulated. (C.H.)

22453 (TID-7632(p.306-11)) THE POSSIBILITY OF GROUND WATER CONTAMINATION BY FALLOUT. Alfred Clebsch, Jr. (Geological Survey, Washington, D. C.) and Joseph A. Lieberman (Division of Reactor Development, AEC).

Results are summarized from a number of investigations of water-supply problems that could arise from contamination of streams and reservoirs by bomb debris in the event of a nuclear attack. Geohydrologic terranes are described that by reason of their geologic structure and mineralogic characteristics provide the highest degree of safety from fall-out contamination. The type of groundwater reservoirs that are susceptible to contamination as a result of massive deposition of bomb debris are also described. It is pointed out that, with the exception of tritium, no fall-out has been detected in ground water to the present time. (C.H.)

22454 (TID-7632(p.318-47)) SUMMARY OF SESSION, FIRST NATIONAL SYMPOSIUM ON RADIOECOLOGY 1961, CYCLING IN THE TERRESTRIAL ENVIRONMENT. Stanley I. Auerbach (Oak Ridge National Lab., Tenn.).

The impact of radioactivity on the biological or ecological systems that comprise the biosphere is discussed from the standpoint of effects on man's well being and economy. Major pathways of transfer of mineral nutrients and radioisotopes between compartments in a forest ecosystem are outlined. It is pointed out that cycling of nuclides in complicated ecological systems involves both rate processes and transfer mechanisms. Data are summarized from a number of studies on ecological factors that affect the initial distribution of radioactive contamination in the biosphere, its subsequent circulation and accumulation, its ultimate fate, effects of radiation from radionuclides on natural ecosystems, and transfer of radionuclides through food chains to man. It is stressed that the understanding of the biogeochemistry of natural major and minor elements in ecosystems is closely related to the interpretation of the movement of radioactive contaminants through these systems. The possibility of such contamination arising from radioactive waste disposal, weapons fall-out, or nuclear war, leads to the need for mathematical models of conditions that could predict the extent and time scale of such contamination. (C.H.)

22455 (TID-7632(p.348-59)) SUMMARY OF REPORTS ON FALLOUT NUCLIDES IN THE MARINE ENVIRONMENT PRESENTED AT THE 1961 RADIOECOLOGY SYMPOSIUM. Allyn Seymour (Washington. Univ., Seattle. Lab. of Radiation Biology).

Summaries are presented of 12 papers that report the results of both field observations and laboratory experiments related to biological, physical, and chemical aspects of fall-out nuclides in the sea. Topics discussed include the availability of sediment-sorbed materials to marine biota, microorganism behavior in radioactive environments, cycling and levels of certain fission products in ocean waters at various locations, the effect of environmental ions on the concentration of certain radioisotopes by marine organisms, radioactivity in marine organisms collected at various locations, and the turnover of phosphorus in aquatic environments. Fission products of special interest include Sr^{90}, Ce^{144}, Pm^{147}, and Zn^{65}. (C.H.)

22456 (TID-7632(p.360-71)) RADIONUCLIDES IN THE FRESHWATER ENVIRONMENT. Louis A. Krumholz (Louisville, Ky. Univ.).

Results are summarized from a number of studies on the uptake, accumulation, retention, and/or loss of radionuclides by organisms in freshwater environments. The

radioactive materials considered include those contained in waste materials from major atomic energy installations, radium in natural waters, phosphorus, naturally occurring radionuclides in a stream ecosystem such as U^{238} and Th^{232}, measured as Bi^{214} and Ac^{228} respectively, and fall-out materials, with emphasis placed on Sr^{90}, Cs^{137}, Zr^{95}, Ru^{106}, and Ce^{144}. (C.H.)

22457 (TID-7632(p.376-80)) STRONTIUM AND BARIUM IN BONE AND DIET. William E. Grummitt (Atomic Energy of Canada Ltd. Chalk River Project, Chalk River, Ont.).

Some 30 components of diet were analyzed for Sr, Ba, and Ca content by neutron activation analysis of the ashed material. The distribution of Sr in the population and in various components of the skeleton was also measured. Data are tabulated on the observed ratio of Ba/Ca and Ba/Sr in bone and diet for various age groups. Applications of the data in predictions of the effects of fall-out from nuclear weapons on populations are discussed. (C.H.)

22458 (TID-7632(p.405-411)) STRONTIUM-90 IN NEW YORK CITY AND SAN FRANCISCO DIETS RESULTING FROM THE OCTOBER 1961 SOVIET TEST SERIES. Joseph Rivera (New York Operations Office. Health and Safety Lab., AEC).

All the foods likely to constitute a typical adult diet were purchased in local stores at New York City, Chicago, and San Francisco at three-month intervals and analyzed for Sr^{90} and Ca after being prepared as if for consumption. It was found that by far the largest contribution of Sr^{90} to the average annual diet is from milk and dairy products. The contamination of all foods was traced to the contamination of plants. A formula is presented for the prediction of Sr^{90} levels of diets. Calculations are presented for New York City and San Francisco as an indication of the likely fluctuation in Sr^{90} dietary content due to fall-out from Soviet detonations in Oct. 1961. (C.H.)

22459 (TID-7632(p.415-24)) AN INVESTIGATION OF THE REPRESENTATIVENESS OF 'GRAB-SAMPLING' IN Sr^{90} IN DRIED MILK PROGRAM– PRELIMINARY RESULTS. P. M. Bird, P. G. Mar, (Canada. Dept. of National Health and Welfare. Radiation Protection Div., Ottawa), G. H. Josie, and F. E. Hobson (Canada. Dept. of National Health and Welfare. Research and Statistics Div., Ottawa).

Results are presented from a statistical analysis of sampling methods used in the collection of samples of powdered milk. The samples are analyzed for Sr^{90} content as part of a program of radioactive fall-out monitoring. (C.H.)

22460 (TID-7632(p.426-56)) FALLOUT AND THE FOOD CHAIN: A STATUS REVIEW. C. L. Comar, R. H. Wasserman, F. W. Lengemann, and J. C. Thompson, Jr. (Cornell Univ., Ithaca, N. Y.).

Results are reviewed from a number of studies of the relationships between the radionuclides released to the biosphere by nuclear explosions and the harm that may be caused thereby to the human population. It is pointed out that this relationship is complex because of varying pathways through the food chain, differing dependence on fall-out rate and cumulative totals, and differing holdup times. Emphasis is placed on data on the paths of Sr^{90}, Cs^{137}, and I^{131} through the food chain to man. Data are tabulated from food surveys and measurements of the deposition and retention of these nuclides in man. Emphasis is placed on the transfer of Sr^{90} through milk to man. (C.H.)

22461 (TID-7632(p.457-76)) PREDICTION OF THE Sr^{90} CONCENTRATION IN THE WORLD POPULATION. J. Laurence Kulp (Columbia Univ., Palisades, N. Y. Lamont Geological Observatory).

Procedures are described for use in estimating future Sr^{90} levels in the human population as a result of a given nuclear explosion. It is necessary to know the fraction of the debris that enters the stratosphere, the time it stays there, and the pattern of surface deposition. The relation of deposition to Sr^{90} content of milk, the relation of milk to total diet, and the discrimination factor from diet to bone are considered. The procedures make it possible to estimate the concentration of Sr^{90} in skeleton in the average person of any age at any locality. (C.H.)

22462 (TID-7632(p.477-516)) CESIUM^{137} LEVELS IN UNITED STATES POWDERED MILK AND IN THE POPULATION. E. C. Anderson, G. M. Ward, J. Z. Holland, and W. H. Langham (Los Alamos Scientific Lab., N. Mex.).

Samples of powdered milk from major production areas in the U. S. were collected at weekly intervals and assayed for Cs^{137} and naturally-occurring K^{40} from 1957 to 1960. People from various sections of the country were also analyzed for Cs^{137} by whole-body counting methods. Data are tabulated. The radiation exposure of the U. S. population from Cs^{137} fall-out deposited on the ground and ingested through milk and other foods was calculated. It is concluded that the radiation exposure from Cs^{137} is relatively insignificant compared to normal variations in natural background rate or to existing guidance levels for occupational exposure to radiation. (C.H.)

22463 (AERE-Trans-891) EMERGENCY MEASURES AND TREATMENT IN CASES OF ACCIDENTAL OVER-EXPOSURE TO RADIATION OR RADIOACTIVE CONTAMINATION. H. Jammet (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). Translated by Catherine T. M. Herriott (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.) from reprint CEA-1502. 1959. 10p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract no. 16921.

22464 SAFER THAN SAFE? Atom, No. 68, 116-22 (June 1962).

Data are reviewed from studies on the biological effects of radiation on human populations. Radiological protection standards currently in use are discussed. It is concluded that the standards now followed in radiological protection are based upon exceedingly pessimistic predictions of the possible effects of exposure at very low rates to small doses of ionizing radiation and that no further reduction in these limits should be contemplated in the absence of adequate biological data. (C.H.)

22465 RESEARCH CONCERNING THE RADIATION DANGER TO THE FLIGHT CREW AND THE GROUND PERSONNEL OF THE JET AIRCRAFT. I. MEASUREMENT OF THE CONTAMINATION OF THE CABIN AIR BY FISSION PRODUCTS OF THE STRATOSPHERIC FALLOUT. O. C. Allkofer, E. Bagge, and J. Truemper (Inst. for Pure and Applied Nuclear Physics, Kiel). Atomkernenergie, 7: 173-8(May 1962). (In German)

Investigations were carried out on the radiation hazard for the flying crew and the servicing staff working at the jets of the Deutsche Lufthansa. The mean cruising altitude of these jets is about 10000 m. The measurement program consisted of three points: measurement of the air contamination with fission debris of the fallout from the stratosphere within the cabin; measurement of the surface contamination of the aircraft; and measurement of the radiation hazard by the cosmic rays. The measurement of the air activity in the cabin was carried out during

February and March 1961, using as usual a dust filter assembly. The dust was collected during flights from Frankfurt–New York and Frankfurt–San Francisco. The concentration of the activity was found to be 3×10^{-13} $\mu c/cm^3$ air. By comparing the measurements with others it was established that 14% of the activity in the stratosphere will be found again in the cabin of the aircraft. It is supposed that the remainder of the activity is stored in the air conducting system. The usual daughter products of the radium and thorium series which are collected commonly at ground level were not found at high altitudes. (auth)

22466 AN IMPROVED METHOD FOR DETERMINING THE ACTIVE CONCENTRATION OF NATURALLY RADIOACTIVE AEROSOLS. J. Thomas (Inst. of Industrial Hygiene and Occupational Diseases, Prague). Atomnaya Energ., 12: 431-2(May 1962). (In Russian)

Airborne activity is usually determined by passing a given amount through a filter and measuring the α-activity of the filter; the results are expressed as a percentage of the maximum permissible concentration. Certain simplifying assumptions must be made concerning the short-lived isotopes. In order to ascertain that these approximations are valid, the degree of disturbance of the equilibrium between Rn and its decay products must be established. Calculations indicate that in the case of a slight disturbance of the equilibrium, the correct value is in average twice larger than the calculated approximate value; under strongly disturbed conditions this divergence is much more marked and therefore a corrected equation should be used. For determining the radiation hazard presented, it is more convenient to determine the total α-energy of the decay products contained in 1 liter of air corresponding to the "latent energy" of the system defined by H. Kusnetz (Amer. Ind. Hyg. Assn. Quarterly 17: 85(1956)). (TTT)

22467 RADIOACTIVE FALLOUT IN CZECHOSLOVAKIA DURING 1959-60. V. Santholzer (Charles Univ., Prague). Atomnaya Energ., 12: 432-3(May 1962). (In Russian)

After the cessation of the atomic tests in the fall of 1958, during the summer of 1959 there was a reduction of the radioactive fall-out level; the average daily level in Czechoslovakia was lowered to 0.03 millicurie/km^2. Similar values were also observed during January and February of 1960, but atfer the first French test in the Sahara the level increased to 1.93 mc/km^2. This increase was only temporary and was followed by another lowering to the 0.02 mc/km^2 level during the period from August 1960 to April 1961. After the second French test on April 1, 1960, a relatively slight short-lived increase was noticed in April, while the third French test on December 27, 1960, not cause any marked changes. The total activity during January 1961 was 0.45 mc/km^2 while the sum of the directly measured activity was only 0.25 mc/km^2. For the 4 six-months long periods starting on Nov. 1, 1958, the total activities amounted to the following values: 121, 54, 19, and 6 mc/km^2. In 1961 up to April 14 the daily average activity was again 0.02 mc/km^2. The background activity also reflected the effect of the French tests. (TTT)

22468 PROVIDING FOR WATER UTILITY OPERATION AFTER NUCLEAR ATTACK. Fenner H. Whitley (Medical Field Service School, Fort Sam Houston, Tex.). J. Am. Water Works Assoc., 54: 621-30(June 1962).

Because of the resumption of nuclear bomb testing and increasing cold war tensions, it is important that water utilities take immediate steps to develop emergency plans to cope with a nuclear disaster. A number of water utilities have already done so, but too many have not faced up to the problem of emergency planning. Careful attention should be given in the emergency planning steps outlined in the following paper. Especially worthy of emphasis is the need for personnel training, particularly in the use of emergency radiation monitoring equipment and interpretation of the readings. Such instruction is highly important for utilities using surface water supplies. It should be pointed out, too, that emergency monitoring equipment is considerably less expensive and requires much less skill to operate than does low-level peace-time equipment for radioactivity measurement. Because of rapid technological developments, there is a continuing need for more information to assist utilities in emergency planning. The AWWA Board of Directors, during its January 1962 meeting, accordingly approved the formation of the Committee on Civil Defense Planning and Operations. The time for water utilities to plan for emergencies is now, however. Plans should be developed on the basis of existing facts and modified as new information is released. (auth)

22469 THERMOLUMINESCENT DOSIMETRY WITH CaF_2: Mn. M. Frank and L. Herforth (Technische Universität, Dresden). Kernenergie, 5: 173-6(Mar. 1962). (In German)

β and γ radiation doses in the range 1 to 10,000 rad or r could be measured by thermal illumination of CaF_2: Mn. The phosphor CaF_2: Mn shows dose proportionality and sufficient storage capacities. A simple dosimeter was described. The method for the preparation of CaF_2: Mn was given. (tr-auth)

22470 SAFETY AND HEALTH CONTROL OF URANIUM FACTORY. Takashi Kitabatake, Yoji Mizutani, and Shunzo Okajima. Nagoya J. Med. Sci., 24: No. 1, 25-32 (1961).

Health and safety control of a uranium milling factory in Nagoya City, Japan, was conducted for the past 2 years. External irradiation from the uranium ingot was negligible. Concentration of uranium in air was a little increased in the operating room, though variation of radioactivity lay nearly within the range of maximum permissible concentration. Uranium concentration in the waste water of the factory was below the maximum permissible dose. Medical examination, including general physical examination, revealed no new abnormalities as the result of uranium exposure. (Pub. Health Eng. Abstr.)

22471 SUMMARY REPORT OF FIVE INVESTIGATIONS ON REACTOR SAFETY. R. Kuester, O. Machnig, L. F. Franzen, H. Huebel, E. Schoenfeld, P. Dosch, and K. Stelzer. IAEA Preprint SM-24. 45p.

To be published in the Proceedings of the IAEA Symposium on Reactor Safety and Hazards Evaluation Techniques held in Vienna, 14-18 May 1962.

Maximum Credible Accident (MCA) for a Gas-Cooled Pebble-Bed Reactor. The MCA for this type reactor results only in the release of the stationary cooling gas activity into the containment vessel and subsequently into the open air by leakage. The escape of fission products from the fuel pellets into the cooling gas is considered, and for the AVR reactor, the total cooling gas activity is $\sim 10^5$c. A maximal dose of 0.2 rem is calculated for a person staying for 48 hr at the most dangerous position. Source Strength, Dose Rate, and Dosage of Direct Radiation at 100% Core Meltdown. Calculations were made for a water-cooled and -moderated UO_2 reactor operated at its rated thermal output of 100 Mw for 650 days and then caused to undergo core meltdown due to maximum credible accident. Figures are presented for the activity of fission products inside the containment and leaking therefrom, and for the

dose rates and dosages of direct radiation at various distances from the reactor site. Safety of OMR Maritime Reactor under Hazardous Conditions. An analog simulation of coolant flow loss and system pressure loss was made to study the transition from normal to auxiliary cooling conditions. The results show that the highest wall temperature of the fuel element is 430°C with no risk of can damage, and that burnout heat flux is exceeded for only 0.65 sec. Design of Safety Systems Against Reactivity Perturbations. The properties of a reactor safety system capable of overcoming reactivity disturbances are discussed. The parameters influencing the cause of disturbance and shutdown are examined, with special attention on the extent to which a negative temperature coefficient can relax the performance specifications for an automatic safety system. Time Delay for the Formation of Radiolytic Bubbles and its Effect on the Dynamic Behavior of FRF. A series of start-up and shutdown experiments with powers from 250 w to 10 kw were performed on the water-boiler homogeneous reactor FRF. The results show that the delay in gas evolution is considerable and that the recombination system of FRF must be kept in operation for a considerable time after reactor shutdown. Experiments on the dynamic behavior of FRF show that safety experiments performed on the KEWB reactor cannot be used without modifications to predict the behavior of FRF. (D.L.C.)

22472 PRINCIPLES OF SAFETY IN THE OPERATION OF NUCLEAR REACTORS. C. K. Beck and F. J. Shon (U. S. Atomic Energy Commission, Washington, D. C.). IAEA Preprint SM-24/39. 21p.

To be published in the Proceedings of the IAEA Symposium on Reactor Safety and Hazards Evaluation Techniques held in Vienna, 14-18 May 1962.

The chief accident prevention functions of the operating practices of a reactor facility are to: 1. Give assurance of "on-design" operation. 2. Critically review plant performance and develop revisions and adjustments in design where actual performance is not in accord with expectations of the designer. 3. Detect hazards not foreseen by the designer. The staff functions to minimize the consequences of malfunctions, failures and mishaps by: 1. Being alert to incipient deviations from normal, exploring any deviations or abnormalities, and anticipating situations in which trouble might develop. 2. Maintaining carefully prepared and up-to-date emergency procedures and equipment, and plans for coping with any emergencies likely to arise. The role of training in each of these functions is discussed, and the problems of using highly trained personnel in jobs that may be largely routine are recognized. The organizational structure and its influence on the safety functions are investigated, and the important problem of reconciling centralized responsibility with the necessity for broad review of operational decisions is educed. The desirability of preplanning and the establishment of considered routine is noted. (auth)

22473 POST STARTUP REACTOR SAFETY. A. A. Johnson (E. I. du Pont de Nemours and Co., Aiken). IAEA Preprint SM-24/40. 24p.

To be published in the Proceedings of the IAEA Symposium on Reactor Safety and Hazards Evaluation Techniques held in Vienna, 14-18 May 1962.

Ideally, by the time a reactor has been designed, constructed, and started up, practically all of the safety problems should have been identified, considered, defined, and analyzed, and the results incorporated into the design, or into manuals, procedures and standards. The operating staff should have been trained and pre-startup and startup tests should have demonstrated the adequacy and reliability of equipment and adequacy of procedures. In such an ideal case, it should be possible to achieve and maintain adequate operating safety through the application of relatively straight-forward management principles. Although substantial improvements have been made in reactor safety in recent years, reactor operation has inherently greater potential hazards than most operations, so that additional attention to operating safety is desirable. Generalized safety practices, developed through many years of production reactor operation, are believed to be applicable to achieving optimum operating safety for more recently designed reactors that may incorporate advanced safety features and that are being built on a less hurried schedule. The principles that are important in achieving safety in reactor operation have been widely publicized. They are: 1. Adequate training of personnel. 2. Clear definition of responsibility, authority, and accountability. 3. Use of written procedures for all operations. 4. Provision of standards and limits within which the reactor must be operated. 5. Review of the operation at high levels of responsibility. 6. Thorough analysis of all unusual incidents. This paper describes in some detail how the above principles have been made to work in practice in the operation of production reactors. The general theme is post-critical reactor safety optimization, including technical problems of safety, examination and analysis of safety systems, effects of programmatic and procedural changes, and use of supporting organization and management review procedures of changes affecting reactor safety. (auth)

22474 PRINCIPLES AND PRACTICES IN REVIEWING HAZARDS SUMMARY REPORTS. Edson G. Case (U. S. Atomic Energy Commission, Washington, D. C.). IAEA Preprint SM-24/41. 16p.

To be published in the Proceedings of the IAEA Symposium on Reactor Safety and Hazards Evaluation Techniques held in Vienna, 14-18 May 1962.

The information contained in Hazards Summary Reports submitted for safety review and evaluation can be generally divided into two categories. Information in the first category relates to the design of the facility and the procedures to be followed in its construction and operation, while the second basic ingredient of a Hazards Report consists of analyses of potential accidents, including an analysis of the so-called "Maximum Credible Accident." The technical staff of a reactor licensing group in its review of these reports considers information in these two categories both separately and collectively. Information on general design characteristics and type is utilized to evaluate the general suitability of the site and containment features proposed. Design details are scrutinized to identify novel and unusual features, and to evaluate the adequacy of the design of those features which have been shown to be susceptible to malfunction as the result of experience from other reactors. Procedures are reviewed to determine compliance with established exposure limits for operating personnel and for the general public. After familiarization with and evaluation of facility design and operating procedures, the reviewer proceeds with the evaluation of the analyses of credible accidents. The course and consequences of "standard accidents," such as a start-up accident, may be used to measure the degree of inherent and engineering safeguards features provided by comparing these analyses with those of similar accidents on similar reactors. Consideration of the assorted accidents which could possibly arise from failures, malfunctions or misoperations leads eventually to an identification or postulation of the "Maximum Credible Accident," an event which would have hazardous consequences not expected to be exceeded by any

accident whose occurrence during the life of the plant would be considered credible. The results of this accident are then analyzed, within the context of the location, safeguards and protective features involved. Such accident analyses lead to an appraisal of the adequacy of the reactor characteristics and reactor safeguards to prevent accidents or minimize hazardous consequences if one should occur, and is an important factor in determining whether or not a reactor facility can be operated without undue public hazard. (auth)

22475 THE ROLE AND PROGRAM OF SAFETY RESEARCH IN RELATIONSHIP TO REACTOR SAFETY. Joseph J. DiNunno and Stanley A. Szawlewicz (U. S. Atomic Energy Commission, Washington, D. C.). IAEA Preprint SM-24/43. 30p.

To be published in the Proceedings of the IAEA Symposium on Reactor Safety and Hazards Evaluation Techniques held in Vienna, 14-18 May 1962.

Safety evaluation of reactors in the United States is based heavily upon information accumulated as a result of developmental programs intended primarily to provide a foundation on which safe design and operation could be based. Because of the diversity of programs related to numerous developments on a variety of reactors and the wide spectrum of sciences involved, the safety evaluator is presented with the challenging problem of keeping abreast of many reports on such developments in terms of their significance to nuclear safety. There have been several ways established in the United States for making more readily available to the hazard evaluators the results of current reactor developments pertaining to safety. In addition to the safety research work conducted as a part of reactor design and development programs, the AEC is supporting extensive work specifically oriented toward providing a more objective basis for evaluating the safety of reactors through better understanding of the pertinent factors. Some important elements in the AEC's safety research program as they relate to questions on reactor safety are discussed. A close relationship was found desirable between those who implement such programs and those who must apply the results derived. A system for accomplishing this type of co-ordination was established. (auth)

22476 DEVELOPMENT OF REACTOR SAFETY STANDARDS. M. C. Leverett (General Electric Company, Richland, Wash.). IAEA Preprint SM-24/42. 28p.

To be published in the Proceedings of the IAEA Symposium on Reactor Safety and Hazards Evaluation Techniques held in Vienna, 14-18 May 1962.

Formal reactor safety standards are in essence written statements of what constitutes good and safe practice in reactor work, issued with the assent of experts in the field. They are voluntarily arrived at, and their observance is not mandatory unless made so by governmental authority. In the United States of America the American Standards Association centralizes the development of reactor safety standards. Reactor safety standards vary greatly in specificity from one to another aspect of reactor safety, depending upon the degree to which recognized good practice has evolved. Standards are being developed in almost all areas of reactor safety. The more specific standards are developing in the mechanical engineering field, where the practices of vessel and piping fabrication and design are well recognized and in the handling of fissile materials. Less specific but still useful standards are evolving in the areas of control system design and operation, reactor system stability investigation, atmospheric dispersion of fission products, operator qualification and organization. Some subjects, such as reactor siting, appear difficult to standardize in even a general way. The voluntary creation of safety standards by the nuclear industry, which standards the industry itself can alter by due process, will probably obviate the need for some governmental regulations on nuclear reactors, and is of assistance to the government in establishing those regulations which are necessary. (auth)

22477 SAFETY PRINCIPLES AND PRACTICES AT SWEDISH EXPERIMENTAL REACTORS. L. Caribom and R. Vestergaard (Aktiebolaget Atomenergi, Stockholm). IAEA Preprint SM-24/1. 21p.

To be published in the Proceedings of the IAEA Symposium on Reactor safety and Hazards Evaluation Techniques held in Vienna, 14-18 May 1962.

The paper gives a survey of the safety principles underlying the design and siting of the Swedish reactors, R0, R1, R2, R2, R2-0, FR0, and R3. The development of the ideas of reactor safety during the realization of the Swedish reactor program is sketched with references to salient features of the different reactors. Safety problems of a general nature are discussed in connection with the practical experiences gained during design, construction, and operation of the Swedish reactors. The relative merits of alternative solutions of both organizational and technical safety problems are considered against the background of experienced mistakes and faults. (auth)

22478 SAFETY IN THE DESIGN, INSPECTION AND TESTING OF A FISSILE IRRADIATION EXPERIMENT IN A HIGH FLUX REACTOR. J. F. Ablitt and O. S. Plail (United Kingdom Atomic Energy Authority, Risley, Eng.). IAEA Preprint SM-24/50. 47p.

To be published in the Proceedings of the IAEA Symposium on Reactor Safety and Hazards Evaluation Techniques held in Vienna, 14-18 May 1962.

The hazard evaluation of a research or materials testing reactor consists of two main parts, the first being the safety assessment of the reactor itself, and the second being the continuous process of safety assessment of irradiation experiments and of their inter-relation with the parent reactor. Once loaded, experimental equipment becomes part of the parent reactor as far as operation and safety are concerned. This paper is devoted to the second part of the over-all hazard evaluation. The basic principles applicable to the safety of irradiation experiments are stated, and brief reference is made to a procedure by which evaluation can be carried out. A typical fissile irradiation device is described and the safety considerations implicit in its design are brought out. The design itself is then reviewed, illustrating the manner and extent to which the safety principles and detail design considerations have been met. Adequacy of heat removal, loss of coolant, melt-out, leakage, liquid metal-water reactions, etc., are dealt with in this way. The safety, as well as the over-all success, of a good design finally depends on thoughtful assembly and precise inspection and testing, with close control over conditions throughout. These aspects are covered in some detail as an example of the standard which must be achieved. In addition to the normal dimensional inspection, specifications and methods are described for circuit cleansing, flow, hydraulic and gas pressure testing, electrical testing of heaters and thermocouples, radiographic examination and heat capacity tests, and life testing of the completed assembly. The method of canning of the fissile specimen is defined and the paper concludes with some mention of the test reports required and of the final review of these and of the advisory safety committee's recommendations,

which contribute to the acceptance by the Reactor Manager of responsibility for loading. (auth)

22479 REACTOR SAFETY ASSESSMENT EXPERIENCE IN THE UNITED KINGDOM. F. R. Farmer (United Kingdom Atomic Energy Authority, Risley, Eng.). IAEA Preprint SM-24/76. 9p.

To be published in the Proceedings of the IAEA Symposium on Reactor Safety and Hazards Evaluation Techniques held in Vienna, 14-18 May 1962.

A discussion is given of some of the basic requirements of a safety assessment, and various methods by which these requirements are achieved in practice. During the course of the safety assessment, various reports and memoranda are prepared by the Authority Health and Safety Branch, dealing in turn with general and specific requirements, recommendations of good practice, and providing the tools by which recurring problems can be efficiently and readily solved. It is suggested that in a rapidly developing technology there is only limited scope for either mandatory codes or rigid criteria. It is, however, necessary to clarify the basis on which a given reactor is likely to be judged as soon as possible in the design cycle, to enable the designer to strike the proper balance between the high standard sought in reactor safety and any corresponding economic or operational penalty. An essential element of this approach is the stimulation of informal discussion by the publication of memoranda leading to the logical development of criteria for reactor safety. (auth)

22480 SAFETY PROVISIONS FOR RESEARCH REACTORS. V. Surya Rao, S. L. Kati, A. K. Ganguly, and S. D. Soman (Atomic Energy Establishment, Trombay, India). IAEA Preprint SM-24/18. 30p.

To be published in the Proceedings of the IAEA Symposium on Reactor Safety and Hazards Evaluation Techniques held in Vienna, 14-18 May 1962.

Since experimental reactors are used mainly for research in basic sciences and isotope production, it is desirable to locate them near universities and industrial centers. However, the radiation hazards attendant with nuclear reactors during normal operation and accidental conditions set limitations on their siting. By proper design and administrative control, even high power reactors (5 Mw) can be made safe enough for locating them near centers of large population. Canada-India Reactor is a high flux research reactor (40 Mw) in the Atomic Energy Establishment Trombay and is located only about 6 miles from Bombay. The radiation hazards from this reactor to plant, personnel, and the population and provisions made to keep them well below permissible levels even under the maximum credible accident are outlined. Confinement of radio-iodine is achieved by suitable modifications to the designed ventilation system. The sub-basement and emergency dump tanks provide enough capacity to contain large volumes (up to 2 million gallons) of highly active cooling water that may arise in the event of a major accident. (auth)

22481 A BIOLOGICAL CONSIDERATION OF DOSES RECEIVED BY EXPOSURE TO RADIOACTIVE AEROSOL RELEASED IN A HYPOTHETICAL REACTOR ACCIDENT AND EVALUATION OF THE HAZARD. M. Suzuki (International Atomic Energy Agency, Vienna). IAEA Preprint SM-24/16. 29p.

To be published in the Proceedings of the IAEA Symposium on Reactor Safety and Hazards Evaluation Techniques held in Vienna, 14-18 May 1962.

The dose received by man encountering a radioactive cloud released by a hypothetical big reactor accident varies greatly, according to many factors. The doses from external exposure to radioactive clouds and by inhalation of radioactive aerosol were calculated, based upon assumptions concerning some characteristics of aerosol, condition of exposure, and biological factors, and it was found that great variability is to be expected of the doses accumulated in different parts of the body. Certain biological evaluations were made on the variability of the doses by setting up certain criteria on tentative permissible emergency doses. Four kinds of fission products release and two exposure conditions were assumed. Calculations of dose were made on five different parts of the body assumed to be critical. (auth)

22482 THE RELATIVE YIELDS OF RADIO-IODINE FISSION PRODUCTS AND TELLURIUM-132 AND THEIR RELATION TO THE HAZARDS FROM ACTIVITY RELEASED IN A REACTOR ACCIDENT. K. Boddy (Associated Electrical Industries Limited, Aldermaston, Berks, Eng.). IAEA Preprint SM-24/13. 22p.

To be published in the Proceedings of the IAEA Symposium on Reactor Safety and Hazards Evaluation Techniques held in Vienna, 14-18 May 1962.

The results of computations of the relative yields of radioiodine fission products for a variety of reactor operating programs are presented. When radioiodine is inhaled or ingested it is concentrated in and irradiates the thyroid. Iodine-131, being the longest lived of the radioiodine fission products, is regarded as the main danger, but since in the case of inhalation the intake may be of short duration, thyroid doses from other iodine isotopes can be appreciable. A knowledge of the relative abundances of the radioiodine isotopes is also necessary in any attempt to assess the milk contamination hazard from grass monitoring. (auth)

22483 POPULATION DISTRIBUTION CRITERIA IN SITING OF NUCLEAR REACTORS. J. Tadmor (Israel Atomic Energy Commission, Rehovoth). IAEA Preprint SM-24/12. 21p.

To be published in the Proceedings of the IAEA Symposium on Reactor Safety and Hazards Evaluation Techniques held in Vienna, 14-18 May 1962.

In selecting a site for a nuclear reactor, a compromise must be found between the degree of reactor safety, i.e., containment and other technically and economically obtainable reactor safeguards, and the degree of risk to be accepted for the population living in the neighborhood, i.e., the size of the exclusion and the restricted areas provided around the reactor. Several criteria of permissible population distribution around nuclear reactors are studied and their advantages and disadvantages discussed. The "genetic dose" aproach complemented by the "expected benefit" approach is suggested as an advantageous population distribution criterion in siting of nuclear reactors. The third party liability insurance which the owner of the reactor and the government are willing to provide is proposed as a suitable gauge of the expected benefit from the operation of the reactor. A comparative study of the different criteria is made for the siting problem of the Israeli Research Reactor-I with regard to the allowable population distribution around the reactor site. (auth)

22484 STANDARDS, ORGANIZATIONAL PROCEDURES AND REGULATIONS RELATING TO REACTOR SAFETY IN MEXICO. V. Serment, L. Gálvez, R. Treviño, and C. Vélez (Comisión Nacional de Energia Nuclear, Mexico City). IAEA Preprint SM-24/3. 33p. (In Spanish)

To be published in the Proceedings of the IAEA Symposium on Reactor Safety and Hazards Evaluation Techniques held in Vienna, 14-18 May 1962.

The main features of a draft safety code for nuclear reactors in Mexico are outlined. As there are no immediate plans for the construction of power reactors in Mexico, the proposals deal only with training and research reactors. The main principle observed in the draft is to require, within reason, a maximum of safety measures ensuring that the general population and the staff connected with a reactor will incur no appreciable risk due to its presence, operation, or maintenance. Special emphasis is placed on the organizational aspects of work with the reactor itself in order to ensure strict compliance with regulations and established procedures. The draft specifies the requirements governing grant by the National Nuclear Energy Commission of authorizations and licenses for the construction and operation of nuclear reactors or of licenses to reactor operators. Standards are given relating to periodic safety inspections of nuclear reactors in regular operation, and the factors which must be taken into account with regard to the organization and operation of safety committees are examined. (auth)

22485 AN ANALYSIS OF THE CONSEQUENCES OF THE MAXIMUM CREDIBLE ACCIDENT WITH THE JEN-1 REACTOR. A. Alonso (Junta de Energia Nuclear, Madrid). IAEA Preprint SM-24/78. 49p. (In Spanish)

To be published in the Proceedings of the IAEA Symposium on Reactor Safety and Hazards Evaluation Techniques held in Vienna, 14-18 May 1962.

Results are described of a study made of the JEN-1 Reactor from the standpoint of possible accidents. This is a pool-type 3 Mw(th) reactor located at the "Juan Vigón" National Nuclear Energy Center in the University City of Madrid. It is housed in a pre-stressed-concrete parallelepiped building with walls 20 cm thick. Leakages from the building were measured under a variety of conditions; it was calculated that, in the event of the maximum credible accident, the daily rate of leakage would be approximately 2%. The reactivity in the core is kept down in such a way as to safeguard the reactor against reactivity accidents. An examination of the consequences of coolant-circulation pump and other mechanical and electrical breakdowns has shown that the damage caused by contingencies of this sort would be insignificant. It was found that the maximum credible accident would be brought about by the loss of coolant water following a burst in an experimental channel or the primary circuit. This would cause part of the core to melt, thus releasing several megacuries of fission products. Calculations were made of the direct radiation which would be produced from the building following the maximum credible accident; because of the thinness of the walls of the reactor building the values were high. A study was also made, for the range of meteorological conditions normally occurring in the area, of the atmospheric diffusion of fission products escaping from the building. Marking isodose curves on transparent paper provides a rapid means of determining the areas affected by radioactivity. On the basis of the results obtained, a set of emergency instructions was worked out. These instructions, which are adapted to the possibilities of the research center where the reactor is located, were tried out in simulated accidents. The results are summed up and analyzed. (auth)

22486 PRACTICAL METHODS FOR ESTIMATION OF ATMOSPHERIC DISPERSION AND EXTERNAL EXPOSURE FROM RADIOACTIVE CLOUD. S. Sakagishi and T. Ishihara (Japan Atomic Energy Research Inst., Tokyo). IAEA Preprint SM-24/26. 20p. (In English)

To be published in the Proceedings of the IAEA Symposium on Reactor Safety and Hazards Evaluation Techniques held in Vienna, 14-18 May 1962.

When radioactive gas is discharged into the free air at the time of accident or ordinary operation of atomic plants, discharged effluent is dispersed by atmospheric turbulent diffusion. The concentrations of radioactive airborne substances are governed partly by the source characteristics (height of source, temperature, and velocity of emission of the discharged gases) and partly by meteorological parameters. A brief description of PbI_2 smoke experiments that have been tried within a few kilometers range at Tokai-Mura (Ibaraki Pref., Japan) from 1958 to 1959 is given. The results of experiments show a good agreement with those of computations which are obtained by Meade's method (1960). Ar^{41} gas release experiments (1961) in use of JRR-2 at Tokai Lab. are described in which the gamma ray total external exposure on the ground surface during Ar^{41} cloud passage was measured by a sampling network extended 2 km downwind. The measured exposures show a good agreement with ones which are calculated under the assumption of spatial concentration distributions obtained by Meade's method. (auth)

22487 THE CONSEQUENCES OF ACCIDENTAL RELEASE OF RADIOACTIVE MATERIALS FROM REACTOR CORES OF NUCLEAR POWER PLANTS WITH CONTAINMENTS. E. Stauber and W. Thoemel (Allgemeine Elektrizitäts-Gesellschaft, Frankfurt am Main). IAEA Preprint SM-24/24. 21p. (In English)

To be published in the Proceedings of the IAEA Symposium on Reactor Safety and Hazards Evaluation Techniques held in Vienna, 14-18 May 1962.

The differences between conventional and nuclear plants, essential from the point of safety, are shown. From this the necessity of an analysis of credible accidents is concluded. It is shown which considerations lead to the assumption of characteristic credible accidents to assure the safety and that unrealistic assumptions are avoided. These considerations lead to the point that the specific type and the provided safety devices have to be taken into account. The consideration of credible incidents leads to accidents at which radioactive materials would be released from the core. Such an accident is emphasized as of additional significance for site selection. It is shown that such an accident can be applied to site selection of plants of different types. As an example, the consequences of a total loss of coolant at a water-moderated and cooled power reactor with containment were calculated. The following processes essential at the release of radioactive materials from the reactor core are treated: melting of fuel, selective release of radioactive materials, course of pressure and temperature in the containment, wash-out of radioactive materials, course of the leakage rate and the atmospheric dispersion from a volume source. The results of the calculations are given by means of curves. By means of the described procedure the exposure of individuals can be calculated in a realistic way. The following effects were calculated: 1. source strengths of radioactive materials; 2. direct radiation from the containment; 3. radiation from the plume; 4. internal exposures. The results are considered as characteristic for plants with containments in which a pressure build-up takes place due to such accident. The calculated effects of the plume, which are valid for unfavorable weather conditions, essentially depend on the power, the maximum leakage rate and the molten fuel fraction. Therefore, they are related to a thermal power of 1 Mw and a maximum leakage rate of 1 vol %/day and are given in tables. (auth)

22488 SAFETY EVALUATION OF NUCLEAR POWER PLANT. T. Yamada, et al. (Ministry of International Trade

and Industry, Tokyo). IAEA Preprint SM-24/28. 35p. (In English)

To be published in the Proceedings of the IAEA Symposium on Reactor Safety and Hazards Evaluation Techniques held in Vienna, 14-18 May 1962.

A procedure of safety evaluation for nuclear power plants is discussed, and a concept of the theory of probability is introduced. The probability of accident occurrences, sequence diagram of accident analysis, etc., are discussed. Procedures for hazard evaluation are given for two kinds of fission product releases. (D.L.C.)

22489 RADIATION AND HEALTH. (World Health Organization, Geneva). 1962. 44p. $0.30.

The International Atomic Energy Agency and the World Health Organization sponsored a scientific meeting on the diagnosis and treatment of acute radiation injury in Oct. 1960. The proceedings of this meeting and a review of a number of recent developments in radiation medicine are presented. Topics discussed include the effects of ionization radiation on health, radiation protection, health hazards from nuclear-powered ships, accidental radiation injury, the management of radiation casualties, therapeutic uses of radiation injury, and applications of vital and health statistics in genetic and radiation studies. (C.H.)

22490 HEALTH IMPLICATIONS OF FALLOUT FROM NUCLEAR WEAPONS TESTING THROUGH 1961. Report No. 3 (Federal Radiation Council, Washington, D. C.). May 1962. 12p. $0.15(GPO).

Estimates are presented of radiation doses received by residents of the United States from fall-out from weapons tests through 1961. Possible effects of fall-out on the health of the population are discussed. (C.H.)

INDUSTRIAL APPLICATIONS OF ISOTOPES AND RADIATIONS

22491 (AD-269483) FABRICATION AND FIELD EVALUATION OF A HIGH-CAPACITY, HIGH-EFFICIENCY CHARGE AIR FILTER SYSTEM FOR ARMY AIRCRAFT. PHASE II. EVALUATION OF H-23C ENGINE AIR AND LUBE OIL FILTER SYSTEM BY RADIOACTIVE TRACER TECHNIQUES. (Fram Corp., Providence). Nov. 1961. Contract DA 44-177-TC-495. 54p. (TCREC-TR-61-127)

Design, development, and field testing of a high-capacity, high-efficiency air filter for application on light aircraft engines were studied. Radioactive tracer techniques were employed and a mobile gamma radiation scintillation spectrometer circuit was utilized for rapid wear analyses in flight tests. The top piston ring of one cylinder of a H-23C helicopter engine was irradiated by neutron bombardment, and its wear measured when the engine was protected with various filters and also with no filter in the induction system. A reduction in piston ring wear by a factor of three was noted when the engine was protected with a high-capacity, high-efficiency air filter to one that had no filters. (auth)

22492 (AD-270882) REPORT OF OBSERVATIONS [ON] NUTRITION: RADIATION AND STERILIZATION OF FOODS FOR AUBURN UNIVERSITY, AUBURN, ALABAMA. M. A. Ross (Armed Forces Inst. of Pathology, Washington, D. C.). Sept. 15, 1961. 16p.

The diet fed to two groups of dogs included irradiated codfish or sweet potatoes. There is no evidence that the consumption of irradiated codfish or sweet potatoes, by dogs, produced any histopathologic change that can be attributed to the specific food or level of irradiation. (auth)

22493 (AD-270914) LONG-TERM DOG FEEDING EXPERIMENT WITH IRRADIATED CHICKEN, BEEF AND JAM. Final Report. Section 1 — Procedures and Laboratory Results. Frank R. Blood, William J. Darby, George Elliott, Carl E. Miller, Matthew S. Wright, Richard Dybdahl, Robert J. Dilworth, Donald B. Rogers, Charles W. Scheffer, Jon M. Buhler, George Francis, Donald Mangrum, Robert G. Horn, and Jerry N. Clanton (Vanderbilt Univ., Nashville). [1961]. Contract DA-49-007-MD-779. 85p.

Dogs were fed irradiated chicken, beef, and jam for two years to determine the wholesomeness of the diet or its possible deleterious effects. Irradiated foods were exposed to 2.79×10 to the 6th power and 5.58×10 to the 6th power rads of gamma radiation. The foods were stored at room temperature in #10 commercial food cans for 3 months to a year. The unirradiated control chicken and beef were stored in the frozen state. Diets contained 35% solids of beef, chicken, or jam and 65% Purina Lab meal plus vitamin supplements. Results were compared among the nine diets with respect to hematology, growth, feed efficiency, urine analysis, and reproduction. Hemaglobin values were slightly higher for males on irradiated beef and females on unirradiated beef than for males on non-irradiated beef. Growth was normal, except that males on nonirradiated jam showed poorer response. Feed efficiency was normal. Glycosuria was noted for all diets; this was attributed to high carbohydrate content. Reproduction was poor; this was attributed to the environment of individual metabolism cages. The beef diet showed the best reproduction response; the jam the poorest. (auth)

22494 (AERE-R-2880) REDUCED SCALE MODEL OF INDUSTRIAL IRRADIATOR FOR DOSE DISTRIBUTION MEASUREMENTS. D. B. Dove and J. P. A. Ridout (United Kingdom Atomic Energy Authority. Research Group. Wantage Research Lab., Wantage, Berks, England). Mar. 1959. Reprinted May 1962. 7p.

Design data for industrial irradiation units may be obtained from measurements with a reduced scale model. Validity and applicability of the method are discussed, and relations given between dose rate distributions within the model and full scale unit. (auth)

22495 (NP-11721) RADIATION PRESERVATION OF CANNED FRUITS AND VEGETABLES. Report No. 8 (Final) May 7, 1957 – May 7, 1961. R. A. Gillies (California Packing Corp., San Francisco). Contract QMR&E (Natick) No. 81. 10p.

Packaged dried prunes and apricots were subjected to radiation doses of 0.1 to 2.0 Mrad. Results indicate that a dose of 0.5 Mrad would be sufficient to prevent spoilage by yeasts and molds. Insects, larvae, etc., would be destroyed at much lower doses. After exposure to a dose of 1.5 Mrad the dried fruits had a slight off-flavor and off-odor. At radiation doses over 1.0 Mrad the color, texture, odor, and appearance of the fruit were generally not acceptable. The effects of radiation on tenderness of white asparatus cuts before canning were also investigated. The tenderness of the final product, as measured by a shear press, was affected by the radiation. However, it has not been possible to determine if this difference was significant, or if it would be noticeable by some sensory test. After canning, the radiated asparagus cuts were discolored (brownish) and unattractive. The amount of discoloration increased as the radiation dose increased. (auth)

22496 (NP-11723) A STUDY OF CHEMICAL CHANGES PRODUCED BY HEAT AND BY IRRADIATION OF MEAT AND MEAT FRACTIONS. Report No. 12 (Final) September 24, 1958 – October 23, 1961. W. A. Landmann (American Meat Inst. Foundation, Chicago). Contract DA-19-129-QM-1293. 23p.

Procedures used to determine precursors of the "wet dog hair" odor in irradiated (5 megarad) beef are described and results are discussed. Although a specific precursor fraction was purified no positive identification was made. (auth)

22497 (NP-11724) DEVELOPMENT OF READY-TO-EAT RATION TYPE BEEF ITEMS. Report No. 6 (Final) January 8, 1960 – September 24, 1961. F. L. Kauffman (Swift and Co. Research Labs., Chicago). Contract DA-19-129-QM-1533. 13p.

Irradiation flavor of beef products treated at 4.5 megarads was substantially reduced by use of additives. Roast beef with BBQ sauce had little irradiation flavor as did Italian meat balls. Ground beef with ascorbic acid, $NaNO_2$, NaCl, fresh onion, pepper, and tomato paste, also had little irradiation flavor. Beef steaks irradiated at –196°C had practically no irradiation flavor. (auth)

22498 (NP-11725) EFFECTS OF IRRADIATION ON FRESH FRUITS AND VEGETABLES AND DAIRY PRODUCTS. Report No. 4 (Final) December 9, 1958 – Decem-

ber 8, 1961. W. L. Hock (National Dairy Products Corp. Research and Development Div., Glenview, Ill.). Contract QMR & E (Natick) No. 112. 6p.

Studies on irradiation of several food products were started, but because of unfavorable flavor characteristics developed by the irradiation, the programs were not continued. Dried whey of varying bacterial counts required dosages between 0.8 and 1.6 megarads to reduce the count to less than 10 per gram. Irradiation of the whey even up to 3.0 megarads produced no detrimental flavor in white sauce prepared from the whey. Strawberry preserves in covered glass jars were surface irradiated in doses up to 1.0 megarad. A decrease in mold count was evident and no irradiation odor was produced but bleaching and flavor loss occurred at the surface. Raw whole milk was irradiated at several dosage levels and found to have a flavor of burnt feathers and rancidity. Passage of the irradiated milk through a batch deodorizer eliminated most of the burnt feather odor but not the rancidity. A second test to determine more exactly the pasteurizing and sterilizing dosages was not completed because the process failed to show promise of producing a satisfactory product. (auth)

22499 (NP-11727) A STUDY OF MEAT ENZYMES TO DETERMINE MEANS FOR THEIR CONTROL. Report No. 14 (Final) June 3, 1958–September 15, 1961. W. A. Landmann (American Meat Inst. Foundation, Chicago). Contract DA-19-129-QM-1204. 42p.

Methods for purification and assay of meat proteases were developed. Several isolation procedures were investigated, and a preparative procedure was devised. Only one fraction from irradiated meat contained proteolytic activity. Assays revealed that this material was considerably less active than that obtained from non-irradiated meat. Ferrous ions were found to activate all fractions from non-irradiated meat as well as the fraction remaining active after irradiation. EDTA in general inhibited proteolytic activity. Cysteine was found to activate two C fractions, but did so to a lesser extent than ferrous ions. Complete inactivation by heat and irradiation could not be achieved until a temperature of 140°F was reached, at which temperature heat alone for one hour could inactivate the enzymes. (P.C.H.)

22500 (NS-7) SEWAGE TRACING WITH RADIOACTIVE ISOTOPES, DETECTION EQUIPMENT FOR IN SITU MEASUREMENTS OF P^{32}. K. M. Gibbons (New Zealand. Dept. of Scientific and Industrial Research. Div. of Nuclear Sciences, Lower Hutt). June 4, 1959. 15p.

Counting equipment for the detection of P^{32} in seawater was developed in the course of investigations of the dilution rate of sewage discharged into the sea. Thin walled aluminum Geiger tubes, that are available commercially, were used as the detectors and the auxiliary electronic equipment is transistorized so that all power is furnished from a 12 volt accumulator. During the three trials carried out to date the equipment has performed very satisfactorily. (auth)

22501 (NYO-9575) A STUDY OF THE EFFECTS OF SUB-STERILIZATION DOSES OF RADIATION ON THE STORAGE LIFE EXTENSION OF SOFT-SHELLED CLAMS AND HADDOCK FILLETS. Quarterly Progress Report for the Period February–April 1962. John T. R. Nickerson, Samuel A. Goldblith, and Edmund B. Masurovsky (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2329. 38p.

Total aerobic-facultative and anaerobic (Clostridia) macrocolony count data, plus identification of aerobic-facultative isolates, are presented with analyses and interpretation for both haddock fillets and shucked, soft-shelled clams irradiated at 400,000 to 800,000 rad. The data suggest that haddock fillets may be maintained under refrigeration for 2 to 3 months when treated with 700,000 to 800,000 rad of Co^{60} gamma rays. In the dose range from 550,000 to 650,000 rad the storage life may be extended up to approximately a month and a half, and at 400,000 to 500,000 rad spoilage can be deferred from 2 weeks to 1 month. Shucked, soft-shelled clams appear to be effectively preserved for periods up to 3 months of storage at 0 and/or 6°C when treated with doses of from 650,000 to 800,000 rad. In the dose range of 500,000 to 600,000 rad the storage life may be extended for 2 months, while treatments at 350,000 to 450,000 rad maintain the clams under refrigeration for 2 to 6 weeks. (P.C.H.)

22502 THE ACCELERATION OF THE AGING PROCESS OF ALCOHOLIC BEVERAGES BY γ-IRRADIATION. Yusuke Sumiki. Genshiryoku Kôgyô, 7: No. 7, 25-7(July 1960).

Using γ irradiation, the aging of alcoholic beverages can be accelerated. Plain Japanese sake can be aged within 1 hr with a Co^{60} source of 270 c (total dose 10,000 r). The taste and flavor of fresh sake can be improved with a few thousand r irradiation. The unpleasant flavor of poor grade sake and the yeast taste of new sake can be eliminated by irradiation. For naturally aged sake and compound sake, the change was very little for a dosage of 10,000 r, and beyond this limit the irradiated sakes were over-aged. For both aged sake and new sake, undesirable tastes were detected for an irradiation dosage greater than 20,000 r. When the dosage approached 100,000 r, the typical "irradiation odor" was detected. Therefore, the ideal dosage range is from several thousand r to 10^4 r. At an irradiation dosage of 10,000 r, whisky and brandy were aged rapidly. However, the color was somewhat faded. Distilled Japanese sakes were improved by irradiation, but excess irradiation caused undesirable aldehyde odors. (OID)

22503 INVESTIGATION OF THE IMAGE QUALITY WITH A Co^{60} RADIATION SOURCE OF 20 CURIES USING THE GUP-Co-50-1. E. Becker, H. G. Schoening, and G. Tschorn (Technische Hochschule, Madgeburg, Ger.). Isotopentechnik, 2: 97-101(Apr. 1962). (In German)

The influence of precise preparation on the amount of irradiation and on the radiator-film distance for obtaining sufficient grain and defect recognition was investigated. (tr-auth)

22504 MOISTURE MEASUREMENT WITH A Cd PROBE. V. Schuricht (Universitat, Dresden). Isotopentechnik, 2: 101-5(Apr. 1962). (In German)

A neutron moisture measurement probe with Po-Be source and Cd-covered gamma counting tube (Cd-probe) was built. Experimental investigations of the optimal dimensions of the probe showed that the lead shield between the neutron source and neutron detector must amount to 6 cm and that the use of paraffin moderator is recommended for low moistures. As a comparison criteria for calibration curves, the measurement time was introduced. The developed measurement probe is suited for moisture determination in sand, in sand-lime masses, in foam silicate, and with limitations also in log wood. In addition, of course, in most cases a density measurement is necessary. (tr-auth)

22505 A CONTINUOUSLY MEASURING LEVEL GAGE OF HIGH ACCURACY. P. Hudec and P. Schiller (Commenius-Universität, Bratislava). Isotopentechnik, 2: 105-11(Apr. 1962). (In German)

A suitable level gage for liquids and loose materials is described that can be put together out of commercial build-

ing units. The apparatus utilizes the absorption of gamma radiation. It is an essential characteristic that the radiation source and detector are not found at the same height. Oscillation around the equilibrium position can be avoided in this manner. A unit for level gage regulation can easily be attached. (tr-auth)

22506 THE INDUSTRIAL APPLICATION OF β-RAY EXCITED X-RAYS. II. YIELDS OF X-RAYS. III. INDUSTRIAL RADIOGRAPHY. Shigemasa Enomoto. Nagoya Kôgyô Gijutsu Shikenjo Hokoku, 8: 855-62(Dec. 1959) and 9: 282-8(June 1960).

The number of x photons produced by β particles was determined. The intensity of the x rays with energy greater than 10 kev from a β-ray source, such as P^{32}, $Sr^{90}-Y^{90}$, or Tl^{204} combined with a target of Al, Sr, or Pd was measured with a NaI(Tl) scintillation spectrometer. Maximum yields were obtained by means of a thin front target and a sufficiently thick back target. Results obtained on the radiographic sensitivity of steel thicknesses of 10 to 30 mm with the $Sr^{90}-Y^{90}$ β-ray excited x ray source agreed with those obtained from the calculated values. The results also showed that the sensitivity depended on the detecting position of the sample and on its spread size vertical to the incident radiation. The sensitivity formula can also be applied to γ-ray radiography using Eu^{155}, Tm^{155}, and Ir^{192} as sources and Rumiantsevs' data. (OID)

22507 INDUSTRIAL APPLICATIONS OF THE FLUORESCENT β-RAY EXCITED X-RAYS. IV. THE MEASUREMENT ON THE FLUORESCENT X-RAYS WITH A SCINTILLATION COUNTER. Shigemasa Enomoto and Chizuo Mori. Nagoya Kôgyô Gijutsu Shikenjo Hôkoku, 9: 380-6 (Aug. 1960).

The detection efficiency and energy resolution of a NaI scintillation counter for measuring the fluorescent K x-rays excited by $Sr^{90}-Y^{90}$ β rays were determined experimentally, and some applications of the K x-ray measurements are presented. Results showed that the low energy x-rays below about 100 kev can be detected efficiently with a thin NaI scintillator, which eliminates the effect of the high energy x rays. A separation of 3 or 4 atomic number units is necessary to resolve elements which have the atomic number larger than 40. For example, the resolution of the counter was about 35% for the tin K x ray (25 kev). The K x ray purity ratio, which was increased by using a thin scintillator, was about 50% for the element of the above mentioned atomic number with a 2-mm thick scintillator. The thickness of Cd deposits on Cu less than 10μ was determined, and the contents of a solder were analyzed also. (OID)

22508 INDUSTRIAL APPLICATION OF β-RAY EXCITED X-RAYS. VII. FLUORESCENT X-RAY ANALYSIS. Shigemasa Enomoto and Chizuo Mori. Nagoya Kôgyô Gijutsu Shikenjo Hôkoku, 10: 422-39(July 1961).

The fluorescent x-ray analysis by means of a β-ray source was applied to binary alloy analysis and to coating thickness measurements. The K x-ray radiation obtained from an element by bombardment with β rays from 10 mc of $Sr^{90}-Y^{90}$ was detected by a folder or a pulse height analyzer and studied with a gas-flow proportional counter. The scattered β rays from the sample were removed by an electromagnet arrangement in front of the counter window. The experimental results showed that the scattered β rays were removed efficiently using Husain's experimental formula; the Cu–Zn alloy analysis using Ni 12 to 36 μ thick gave a straight line calibration curve within 2% accuracy; within 0.5% for Cu–Sr containing more than 80% Cu using the pulse height analyzer; and up to 10 μ of Cr deposit can be determined with a 2% accuracy if the thickness is less than 4 μ. (OID)

22509 STUDY OF CATALYST FLOW IN FLUID CATALYTIC CRACKING BY MEANS OF RADIOACTIVE TRACERS. John J. Mitchell and Arthur J. Kinsella, Jr. (to Texaco Inc.). U. S. Patent 3,039,975. June 19, 1962.

A method is given for preparing a Co^{60}-labeled silica-alumina fluid cracking catalyst for catalyst flow studies and for control of fluid catalyst cracking equipment. In the method, a water solution of cobalt nitrate containing Co^{60} is mixed with the catalyst, and the impregnated catalyst is heated to decompose the nitrate. Equipment for injecting the catalyst into a fluid cracking unit are described. (D.L.C.)

ISOTOPE SEPARATION

22510 (TID-15733) FLOWSHEETS AND SUPPLEMENTARY DATA FOR THE HEAVY WATER PLANT DESCRIBED IN CHEM. ENG. PROG. 58: 53-61, NO. 4, APRIL 1962. J. F. Proctor (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.) and V. R. Thayer (Du Pont de Nemours (E. I.) & Co., Wilmington, Del.). Contract AT(07-2)-1. 30p.

Quantitative flow diagrams are given for a large, conceptual plant for the production of heavy water. Included are process flow rates, temperatures, pressures, enthalpies, and deuterium concentrations for the GS and DW units described in The Economics of Heavy Water Production by J. F. Proctor and V. R. Thayer. The unit costs for process materials and utilities assumed in the development of this paper are also included. (auth)

22511 (AEC-tr-5133) SEPARATION OF LITHIUM ISOTOPES BY MOLECULAR DISTILLATION OF MOLTEN LITHIUM. V. A. Malyusov, V. Yu. Orlov, N. A. Malafeev (Malafeyev), N. N. Umnik, and N. M. Zhavoronkov. Translated for Oak Ridge Gaseous Diffusion Plant, Tenn. from Atomnaya Energ., 11: 435-9(Nov. 1961). 13p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 16, abstract no. 6679.

22512 (AEC-tr-5134) ANALYSIS OF A GASEOUS DIFFUSION SEPARATIVE UNIT. Jun Oishi, Yoichi Matsumura, Kunio Higashi, and Chieko Ike. Translated for Oak Ridge Gaseous Diffusion Plant, Tenn. from Nippon Genshiryoku Gakkaishi, 3: 923-8(1961). 16p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 16, abstract no. 7820.

22513 (AEC-tr-5135) ON ISOTOPE SEPARATION BY THE COUNTER-CURRENT GAS CENTRIFUGE. I. INFLUENCE OF A GAS FLOW PATTERN ON THE SEPARATIVE POWER. Akira Kanagawa and Yoshitoshi Oyama. Translated for Oak Ridge Gaseous Diffusion Plant, Tenn. from Nippon Genshiryoku Gakkaishi, 3: 868-73(Nov. 1961). 15p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 16, abstract no. 5637.

22514 (AEC-tr-5136) ON THE ISOTOPE SEPARATION BY THE COUNTER-CURRENT GAS CENTRIFUGE. II. RELATION BETWEEN FEED RATE AND SEPARATIVE POWER. Akira Kanagawa and Yoshitoshi Oyama. Translated for Oak Ridge Gaseous Diffusion Plant, Tenn. from Nippon Genshiryoku Gakkaishi, 3: 918-22(Dec. 1961). 13p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 16, abstract no. 7819.

22515 SEPARATION BY THERMAL DIFFUSION OF THE BINARY MIXTURE $He-H_2$. Gh. Văsaru, C. Ungureanu, and T. Fodor (Institutul de fizică atomică, Cluj). Acad. rep. populare Romîne, Inst. fiz. atomică si Inst, fiz., Studii cercetări fiz., 12: 825-38(1961). (In Rumanian)

A thermal diffusion column, designed to be used as a prototype for the construction of a series of columns in an installation for the separation of isotopes, was investigated. To establish the performances of this column the attainment of equilibrium and the variation of the separation factor as a function of pressure were determined. The results obtained were compared with the theoretical results of Furry Jones and good agreement was found. (tr-auth)

22516 DISTILLATION OF ISOTOPIC MIXTURES IN PROFILE REGIME. D. Barb, R. Bucur, and A. Olariu (Institutul de fizică atomică, Cluj). Acad. rep. populare Romîne, Inst. fiz. atomica si Inst. fiz., Studii cercetări fiz., 12: 879-91(1961). (In Rumanian)

The equation for the distillation separation of an adiabatic binary isotopic mixture is discussed and a generalization is given for the profile regime. It was deduced that the equation is valid for the case of the ternary mixture $H_2O-HDO-D_2O$, and it was concluded that the profile regime is more advantageous than the adiabatic regime in the case where an improved separation in an installation of reduced proportions is desired. (tr-auth)

22517 SEPARATION OF LITHIUM ISOTOPES BY CATION EXCHANGE RESINS USING THE METHOD OF SHARP-EDGED TRAVELING BANDS. N. I. Nikolaev, V. M. Kolotyrkin, and N. N. Tunitskii. Atomnaya Energ., 12: 404-7(May 1962). (In Russian)

The chief difficulty in the separation of Li isotopes by the method developed by F. Spedding et al. (J. Am. Chem. Soc., 77: 6125(1955)) consists in the formation of sharp-edged Li ion bands on the resin. This was successfully achieved by passing a LiOH solution through a KU-2 type resin bed; the front edge was formed as described in the above-cited article while the rear edge was obtained by the substitution of Li^+ ions for the Na^+ ions. A buffer zone containing NH_4^+ ions was used for separating the neutralization zone from the Li band. The method was used for the study of the kinetics of the process and for the determination of the separation coefficient in the traveling band. This coefficient was found to be 1.0010 ± 0.0003 and 1.0055 ± 0.0003 for LiOH and 1.0020 ± 0.0005 for Li_2SO_3. In a 33-cm long traveling band a factor of 1.32 was obtained. The method may be used for separating other elements; substitution of the elements on the ion-exchange resin may be determined on the basis of the lyotropic series. (TTT)

22518 A MICROCOLUMN FOR SEPARATING AND ANALYZING ISOTOPIC MIXTURES OF HYDROGEN. R. F. Bulatova, V. N. Grigor'ev, and V. S. Kogan. Atomnaya Energ., 12: 428-9(May 1962). (In Russian)

Low-temperature rectifying columns without packing were found to be useful for separating small amounts of hydrogen isotopes. The columns are characterized by low entrapment, rapid establishment of equilibrium, and high separating ability at low vapor flow rates. For laboratory purposes the column consisted of a 1-mm-diameter glass tube with a 3-cm^3 boiler portion at the bottom. A vacuum sleeve surrounded the rectifying portion; the upper section cooled by liquid hydrogen served as the condenser. The unit was placed in a Dewar flask. A 3-component system obtained from the electrolysis of 50% heavy water solution in ordinary water served as starting material. It was condensed under vacuum at 15 to 16°K. The electric heating was adjusted to provide a vapor flow rate of 1 cm/sec. The rectification yielded the original mixture of 25% H_2, 50% HD, and 25% D_2 with an error of ±5%. The apparatus is thus useful for analyzing three-component or more complex isotopic mixtures of hydrogen which usually would require the use of a special mass spectrometer. The sharpness of the separation may be improved by reducing the rate. (TTT)

22519 THE SEPARATION OF HYDROGEN ISOTOPES BY DISTILLATION OF AZEOTROPIC MIXTURES OF

STRONG ACIDS WITH WATER. III. THE TEMPERATURE DEPENDENCE OF THE ELEMENTARY SEPARATION FACTOR FOR THE AZEOTROPE NITRIC ACID–WATER. K. Wetzel, H. Schuetze, and G. Kretzschmann (Institut für Physikalische, Leipzig). Isotopentechnik, 2: 16-19(Jan. 1962). (In German)

Because of the contribution of the isotopic exchange equilibria, a large separation parameter $\delta = \alpha - 1 = (D/H)_{steam}/(D/H)_{liquid} - 1$ is to be expected for the distribution of hydrogen isotopes between liquid azeotropic mixtures of strong acids with water and their vapor. In the case of azeotropic nitric acid, $\delta = 0.059$, according to the investigations reported in Parts I and II. By dynamic vapor pressure determination and by batch direct current distillation under reduced pressure, it was shown that the separation parameter in the range from 60 to 120°C is approximately constant and decreases significantly with lowered temperatures. The deuterated nitric acid, DNO_3, used for the vapor pressure determination was prepared by the introduction of a N_2O_5/N_2 mixture into D_2O. (tr-auth)

22520 SEPARATION FACTORS IN THE NO–NOBr SYSTEM. Alfred Narten (Columbia Univ., Upton, N. Y.). J. Phys. Chem., 66: 1189-90(June 1962).

Studies were made of exchange reaction in the NO–NOBr system as a means of separation of the stable isotopes of nitrogen. The effective separation factor was found to the 1.0024 ± 0.0008 at 281°K and 1.0046 ± 0.0005 at 253°K for N^{15}/N^{14}. (M.C.G.)

MATHEMATICS AND COMPUTERS

22521 (ANL-6542) AN INTRODUCTION TO 704 FORTRAN. G. S. Pawlicki (Argonne National Lab., Ill.). Mar. 1962. Contract W-31-109-Eng-38. 19p.

A fraction of the possibilities of Fortran are described, but at all times an effort was made to indicate where only a partial expose was made. Many specific examples are included to illustrate the word descriptions of Fortran programming. An appendix, which gives specific information concerning procedures relative to the use of the 704, is included. (auth)

22522 (DC-60-5-98) SPECIFICATIONS FOR PROGRAMS TO COMPILE AND MODIFY A MULTIPLE RECORD NUCLEAR DATA TAPE (PROGRAMS RNDP, RNDC, RNDM). J. R. Cooper and P. G. Fischer (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Apr. 28, 1960. Contract AT(11-1)-171. 109p.

Specifications are presented for three computer programs designed to compile and modify a reactor nuclear data (RND) tape. The tape will be utilized to provide up-to-date nuclear data for various ANP reactor codes. Program RNDP will compile the tape from nuclear data supplied as input. It will also add and delete complete blocks of data from a tape previously prepared. Program RNDC will copy the tape or write it from sets of binary cards punched by program RNDP. Changes of individual words within a record will be allowed. Program RNDM will compile and add to the tape macroscopic cross sections from sets of microscopic cross sections available on the tape. These programs are to be written as far as possible in Fortran language for the IBM-704 computer with consideration for their later use on the IBM-7090 computer. (auth)

22523 (GAMD-2885) "CTTS" CHANNEL TRAP TAPE SELECT. William A. Growdon (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Jan. 23, 1962. Contract AT(04-3)-314. 37p.

CTS, a set of subroutines designed to execute tape motion for programs which require the ability to buffer while reading and/or writing large data sets, was developed primarily for use by Fortran II programs on the IBM-7090. The data channel trap feature is utilized by this program. It is designed such that a program need not be delayed in order to check for the satisfactory completion of input/output transmissions. (M.C.G.)

22524 (TID-15780) THE PRECOMPILER—A PROGRAM WHICH WILL ALLOW ARBITRARY ARITHMETIC MODES IN FORTRAN PROGRAMS. C. M. Williams (Sandia Corp., Albuquerque, N. Mex.). May 8, 1962. Contract AT(29-1)-789. 5p. (SCDC-2673)

The Precompiler program was developed to allow various arithmetic modes without altering the existing Fortran compiler. To accomplish this the Fortran source deck consisting of a mixture of ordinary Fortran statements and special mode arithmetic statements is fed to the Precompiler which then outputs ordinary Fortran statements consisting of the original ordinary Fortran statements in unaltered form, and compiled versions of the special mode statements. (M.C.G.)

22525 (UCRL-10059) ORGANIZATION OF MULTIPLE OUTPUT FUNCTIONS (thesis). Peter White (California. Univ., Berkeley. Lawrence Radiation Lab.). Feb. 8, 1962. Contract W-7405-eng-48. 67p.

A procedure was developed for determining the most economical p-input, q-output switching circuit required for the implementation of q Boolean switching functions of p variables each. It is shown that the q output functions can be combined into one single function, which is then optimized to yield the least number of "AND" and "OR" connectives. The procedure was then automated via a computer program capable of handling problems of up to ten inputs and fifteen outputs. The program was written in the NELIAC computer language, capable of running on either the IBM 704 or 709 computer. (auth)

22526 (AEC-tr-4491) GENERAL COMPUTATIONAL METHODS OF CHEBYSHEV APPROXIMATION. THE PROBLEMS WITH LINEAR REAL PARAMETERS. E. Ya. Remez. Translation of "Obshchie Vychislitel'nye Metody Chebyshevskogo Priblizheniya. Zadachi s Lineino Vkhodyashchimi Veshchestvennymi Parametrami" (a publication of the Publishing House of the Academy of Sciences of the Ukrainian S.S.R. Kiev, 1957). 757p.

A monograph is presented dealing with numerical methods of constructing Chebyshevian approximations. Part one treats integral methods of effective Chebyshev approximation and properties of solutions of the generalized Chebyshev problem. Part two concerns finite systems of incompatible linear equations and network methods of Chebyshev approximations. (T.R.H.)

22527 VARIATION PRINCIPLE IN STOCHASTIC MARKOVIAN PROCESSES. Ryoichi Kikuchi (Hughes Research Labs., Malibu, Calif.). J. Math. Anal. and Appls., 4: 488-93(June 1962).

A variation principle leading to the kinetic equation in a stochastic Markovian process is proposed. The variation function is the probability that a certain change of state occurs during a short time interval. Analogy between this variation procedure and the principle of minimum free energy in equilibrium statistical mechanics is pointed out. (auth)

22528 PERTURBATION THEORY AND LIE ALGEBRAS. F. J. Murray (Duke Univ., Durham, N. C.). J. Math. Phys., 3: 451-68(May-June 1962).

An approach to perturbation theory is considered based on the formula $\exp(-iB)\,A\exp(iB) = A\exp(iB)$, where $[AB] = AB - BA$ is the commutator. The operators A constitute a linear space $\mathscr{a}$ and the operators B considered are such that B take $\mathscr{a}$ into itself. The discussion considers the case where $\mathscr{a}$ is finite-dimensional with coordinates $c_1, \ldots, c_n$; i.e., $\mathscr{a}$ is isomorphic with the set of n-dimensional vectors c. Under these circumstances sufficient conditions for the basic formula are given in terms of "analytic vectors." The set, $\mathscr{A}$, of B's available can be considered closed under the processes of taking linear combinations and forming the commutator. Thus $\mathscr{A}$ is a Lie algebra. Exponentiation leads to a Lie group of operators U, and A and A′ are said to be B equivalent if $A' = U^{-1}AU$. For finite-dimensional $\mathscr{a}$, each B is associated with an $n \times n$ matrix, b, which specifies the operation B relative to the vectors c. Effectively, then, $\mathscr{A}$ is finite-dimensional. The matrices b form a Lie algebra with a corresponding Lie group of matrices u such that A and A′ are B equivalent if and only if the corresponding two vectors c and c′ are u images; i.e., if $c' = uc$. Computationally, therefore, the set of A′ equivalent to a

given A is obtained by considering the orbit of a given vector c under the Lie group; i.e., the set of uc. A neighborhood $\mathscr{N}'$ of a given A consists of those operators A′ in the form A + δA where δA is arbitrary except for a restriction on the size of its coordinates, c_{ij}. Given A, a neighborhood $\mathscr{N}'$ can be found for which one can obtain by a well-known construction on the orbits a set of functionally complete and functionally independent invariants for B equivalence. Computationally, global and rational invariants are desirable, and these can be obtained in the form of similarity invariants, provided that $\mathscr{A}$ can be mapped onto a set of n × n matrices a in such a way that if c corresponds to a, then bc corresponds to a′ = [ab]. If the sets $\mathscr{A}$ and $\mathscr{B}$ are identical such a mapping is immediately available and if, in addition, the corresponding Lie algebra is semisimple, then in general, given A, the A's in some neighborhood are each equivalent to an A″ which is a function of A. This corresponds to a case in which a very simple perturbation of A levels occurs. Two examples are discussed. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

General and Miscellaneous

22529 (AERE-R-3670) MANUFACTURE OF PLUTONIUM–BERYLLIUM NEUTRON SOURCES. M. J. F. Notley and J. Sheldon (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Mar. 1961. 12p.

The manufacture of several neutron sources by the reduction of PuO_2 with beryllium is outlined. The problem of setting up a production routine is discussed. The handling techniques are discussed and compared with those developed by other laboratories. (auth)

22530 (ARF-3133-23) METHODS OF PURIFICATION OF METALS AND INTERMETALLIC COMPOUNDS. Period covered: June 15, 1959 to May 14, 1960. Sherman Susman (Illinois Inst. of Tech., Chicago. Armour Research Foundation). June 1, 1960. Contract AF33(616)-5895. 134p. (WADD-TR-59-303(Pt.II); AD-267777).

A study was made of impurity transport in thermal gradients and other fields in materials potentially useful for thermoelectric, thermionic, or photovoltaic power generation at high temperatures. The general problem of impurity distributions in an intense thermal gradient was considered. The physical and chemical properties of SiC were considered in the context of diffusion phenomena and thermoelectric behavior at elevated temperatures. Single crystals and polycrystalline rods of SiC were studied. Both chemical and spectrographic analyses were used for the qualitative and quantitative estimation of impurity content. Electrical resistivity and thermoelectric power measurements were made up to 1000°C. Polycrystalline SiC rods were subjected to intense thermal gradients by direct inductive coupling at 5 mc. Impurity redistribution is followed by spectrographic analysis. (auth)

22531 (DC-60-1-51) MATERIALS SURVEY NON-METALLICS–RETAINER PLATE CERAMIC CORE. PART III. F. M. Norton and S. E. Eckard (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Dec. 30, 1959. Contract AT(11-1)-171. 41p.

The use of silicon carbide as a structural material for core retainer plates is described. An accounting of the design history, fabrication, and testing is made for these carbide materials. (auth)

22532 (GEMP-11A) HIGH-TEMPERATURE MATERIALS PROGRAM. PROGRESS REPORT NO. 11, PART A. (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). May 15, 1962. Contract AT(40-1)-2847. 75p.

Materials development for high-temperature applications is reported. Work is described on metallic fuel element materials for greater than 1200°C operation in oxidizing atmospheres, high-temperature control materials, fabricability of high-temperature structural materials, effects of radiation on high-temperature alloys, moderator fabrication and testing, and high-temperature insulation materials. (M.C.G.)

22533 (NAA-SR-Memo-7208) LITERATURE SURVEY–URANIUM MONONITRIDE. W. R. Kerr (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Mar. 14, 1962. Contract [AT(11-1)-Gen-8]. 13p.

A review is given on the uranium–nitrogen system, including the crystallography of its compounds, methods of synthesis and fabrication, physical and chemical properties, irradiation properties, and compatibility of uranium mononitride with other materials. Twenty-nine references are given to books, reports, and journals published from 1948 to 1961. (auth)

22534 (TID-3314) GRAPHITE. A Selected Bibliography. Theodore F. Davis, comp. (Division of Technical Information Extension, AEC). Feb. 1962. 167p.

References (958) on reactor grade graphite are given to reports and published literature selected from Nuclear Science Abstracts (NSA) for the period 1948 through mid-1961. Some information on the manufacture and uses of graphite in other fields is also included. Subject, author, and availability indexes are provided. (P.C.H.)

22535 (AEC-tr-5195) OXIDATION OF ORDINARY OR ALLOYED STEELS HEATED IN CARBONIC GAS UNDER PRESSURE. D. Leclercq, C. Chevilliard, and R. Darras (France. Commissariat à l'Energie Atomique. Centre d'Etudes Nucléaires, Saclay). Translated by A. L. Monks (Oak Ridge National Lab., Tenn.) from report CEA-1407. 1960. 43p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract no. 9731.

22536 (CEA-tr-R-1498) METALLURGIE DU LITHIUM. OBTENTION DU LITHIUM METALLIQUE PAR ELECTROLYSE. (Metallurgy of Lithium. Obtaining Metallic Lithium by Electrolysis). Translated from p.172-93 of "Litii, Ego Khimiya i Tekhnologiya" (Lithium, its Chemistry, its Technology) (a publication of Atomizdat, Moscow, 1960). 63p.

The history of the preparation of metallic Li by electrolysis is reviewed, and various commercial installations are described. The regeneration of spent electrolyte is discussed. Methods for the production of three types of Li alloys by electrolysis are given. The production of Li by metallothermic methods and directly from spodumene is discussed. The purification of the metal and its storage and preservation are described. (J.S.R.)

22537 ELECTROCHEMICAL SEPARATION OF Ti–Al ALLOYS. V. S. Balikhin and V. A. Reznichenko. Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk Met. i Toplivo, No. 2, 49-55(Mar.-Apr. 1962). (In Russian)

Measurements of Ti and Al electrode potentials in molten sodium chloride showed the inefficiency of the ordinary electrolytic method for refining these metals. Electrolytic separation of Ti-Al alloys can be achieved on the basis of low aluminum chloride solubility in molten $CaCl_2$. (R.V.J.)

22538 PREPARATION OF SMALL SAMPLES OF DUCTILE TITANIUM AND ZIRCONIUM FROM THE ISOTOPIC OXIDES BY IODIDE REFINING. N. D. Veigel and J. M. Blocher, Jr. (Battelle Memorial Inst., Columbus, Ohio). J. Electrochem. Soc., 109: 647-8(July 1962).

Samples of ductile titanium-46, -47, -48, -49, -50, and zirconium-90, -91, -92, and -94 in the form of 1-in. long rods were prepared by calcium reduction of the isotopic oxides followed by two-step iodide refining. The final products of the two-step refining could be cold rolled directly to foil less than 0.025 mm thick, while the products of the one-step process cracked in attempts to reach this thickness. Spectrographic analyses are compared for a TiO_2 sample and single-step refined titanium product. (D.L.C.)

22539 MEASUREMENT OF RESIDUAL STRESSES IN STEEL PLATES CLADDED WITH STAINLESS STEEL. W. Hofmann (Institut für Werkstoffkunde, Brunswick). IAEA Preprint CN-13/6. 11p. (In English)

To be published in the Proceedings of the IAEA Conference on the Corrosion of Reactor Materials held in Salzburg, 4-9 June 1962.

The determination of residual stresses in cladded plates is of interest in a double respect: (1) Type and value of the residual stresses being known, the admissible external (mechanical) load of the compound material can be determined on this basis. (2) The tendency of stress-corrosion depends on the type of residual stresses. Two general methods of calculation were developed for determining the residual stresses in a compound material of any combination of metals and any proportion of plate thicknesses. The combination of austenitic steel as a cover and of boiler-plate as a basic material was examined. The thickness of austenitic steel amounted to 15.5% of 19.5 mm total thickness. The problem was restricted to the case of the thin cladded balk. Thin balks of 240 mm length, 10 mm width, and 19.5 mm thickness were cut out from a bigger plate. Residual stresses were calculated from the changes of length, caused by the removal of layers from the original plate thickness. The changes of length were determined with the aid of an Abbe-Comparator at constant temperature, with a mean error of ±0.2 mμ. The gage length was 40 mm. One of the methods of calculation was applied by means of an electronic digital computer. The following three conditions of material were examined: (1) specimen in the state of delivery (2) specimen stretched by 10% and (3) specimen annealed at 1100°C and steadily and slowly cooled. The delivered specimens showed compression stresses in the two outer zones, i.e., in the top- and bottom-sides of the plate, but tensile and compression stresses in the middle of the plate. Tensile stresses in the outer layers and compression stresses in the middle of the plate were found in cases (2) and (3). With respect to the tendency of stress-corrosion in the presence of corroding surroundings, the state of delivery of the plates is therefore most favorable. Strongly deformed compound material (specimen 2) and annealed plates (specimen 3) are likely to show an unfavorable reaction. (auth)

22540 RADIATION-RESISTANT LUBRICANT COMPOSITION. Benjamin E. Gordon and Fred E. Weir (to Shell Oil Co.). U. S. Patent 3,041,282. June 26, 1962.

A method is given for preparing radiation-resistant lubricant compositions. The method comprises stabilizing non-asphaltogenic organic compounds, e.g., oils containing less than 0.1 wt % of asphaltic constituents, with 0.1 to 10 wt % of added asphaltenes. (D.L.C.)

Corrosion

Refer also to abstract 23290.

22541 (AECL-1513) CORROSION AND HYDRIDING BEHAVIOUR OF SOME Zr 2.5 wt % Nb ALLOYS IN WATER, STEAM AND VARIOUS GASES AT HIGH TEMPERATURE. S. B. Dalgaard (Atomic Energy of Canada Ltd., Chalk River, Ont.). May 1962. 38p.

Presented at IAEA Conference on Corrosion of Reactor Materials, Salzburg, June 1962.

Exposed to water at temperatures up to 325°C, the Zr-2.5 wt % Nb alloy has corrosion resistance acceptable for power reactors. Resistance to air and carbon dioxide is less favorable. Addition of Sn, Fe, and Cr to the base alloy has little effect on the corrosion resistance, but the addition of copper reduces corrosion in water and steam to some extent and in air and carbon dioxide to a greater extent. Studies of the effect of heat treatment suggest that the amount of Nb in α solid-solution controls the rate of oxidation and hydriding and that concentration, size, and distribution of second phase is of little importance. Initial results obtained in NRX indicate that a thermal flux of 3 to 7 × 10^{13} n/cm^2/sec has little or no effect on oxidation and hydriding in high temperature water. (P.C.H.)

22542 (ARL-62-377) STUDIES OF OXIDATION OF Ta-10% W AT 700°-1300°C. Technical Note No. 4. Per Kofstad (Sentral-institutt for Industriell Forskning, Blindern, Noway). Mar. 1962. 33p. (SI Publ.-364)

Oxidation of Ta–10% W was studied in the temperature range 700-1300°C. Thermogravimetric studies of oxidation rates and x-ray diffraction, and metallographic and microhardness studies on oxidized specimens were made. The oxidation constitutes oxide formation and oxygen dissolution in the alloy core. The oxide mainly consists of the β-Ta_2O_5 phase. During initial stages the oxidation follows an approximate parabolic behavior during which the oxidation is concluded to be governed by diffusion of oxygen through the β-Ta_2O_5 scale. After longer periods of time below 1100°C the oxide spalls during oxidation. Oxygen dissolution is of little importance in the weight gain studies compared to oxide formation. However, the oxygen diffusion is relatively rapid, and at 700°C the diffusion coefficient is of the same order as for Ta. Concurrently with the oxygen dissolution the alloy is also internally oxidized. This has adverse effects on the mechanical properties as evidenced by cracks in the internally oxidized zone after cooling to room temperature. (auth)

22543 (KR-15) THE PITTING ATTACK ON THE ALUMINIUM CLAD HBWR FUEL ELEMENTS AND THEIR REPAIR. R. H. Soevik, K. Videm, and S. Aas (Norway. Institutt for Atomenergi, Kjeller). Feb. 1962. 25p.

The canning of the HBWR fuel elements, made of aluminum with 0.6% Fe and 0.07% Si, pitted severely during experiments at room temperature, a period during which the D_2O purification system was not operating. The attack was caused by the combination of galvanic action due to coupling to stainless steel, and water with a local high impurity level. The elements were repaired by fitting an aluminum sleeve over the defected part. This was done by turning off the fins and 3/10 mm of the cladding and shrinking the sleeve on. Seal welding was carried out by the argon shielded tungsten arc method by first depositing a stringer of metal on the can, and then joining this weld bead to the sleeve with filler addition. The fuel elements were tested satisfactorily in the reactor at 150°C. (auth)

22544 (KR-19) ALUMINIUM ALLOYS WITH IMPROVED CORROSION RESISTANCE IN HIGH TEMPERATURE WATER. Ketil Videm (Norway. Institutt for Atomenergi, Kjeller). May 1962. 46p.

Small additions of Si to Al-Ni alloys are harmful for the high temperature corrosion resistance while addition of 10% Si give alloys with promising properties. Two Al alloys with a high Si content IFA 2 and IFA 3 were tested in loops together with X8001 aluminum at 230 and 265°C. In tests with high flow rate the oxide film on the X8001 samples was found to flake off after a certain exposure time. Prefilming of the aluminum in autoclaves prior to the loop tests had a beneficial effect on all the tested alloys. The time before break-away was increased and the corrosion rate in this period decreased. Break-away did not occur at all in loop test at 265°C on IFA 2 and IFA 3 aluminum

pretreated in distilled water at 315°C, and the corrosion rate was as low as 60 microns/year. X8001 aluminum suffered break-away after 40 days, and the post-break-away corrosion rate was about 400 microns/year. (auth)

22545 SENSITIZATION AND INTERCRYSTALLINE CORROSION OF 18-8 STAINLESS STEEL. G. Camona (Centro Informazioni Studi Esperienze, Milan). Energia nucleare (Milan), 9: 278-89 (May 1962). (In Italian)

The causes and mechanisms of intercrystalline corrosion of 18-8 stainless steel are discussed. Theories are reviewed. Methods of potentiostatic measurements are illustrated. (auth)

22546 METALLOGRAPHIC OBSERVATION OF OXIDIZED SURFACES. A. Bassi, G. Camona, and G. Dassù (Centro Informazioni Studi Esperienze, Milan). Energia nucleare (Milan), 9: 290-2 (May 1962). (In English)

Techniques for protection of oxide films on surfaces for metallographic observations are discussed. Methods using chemical metallization and resins were studied for preparation of samples for observation of thin oxide layers on Zircaloy-2 tubes. The geometry used did not allow chemical metallization. A resin, which besides polymer, also contained copper powder was used. An electron microscope was used for observations. Perfect adherence of the metallic phase to the oxide was obtained, and excellent conservation of the oxide after grinding and polishing was visible. (M.C.G.)

22547 CORROSION OF NUCLEAR METALLIC MATERIALS IN ORGANIC COOLANTS. G. Ito, F. Sawayanagi, and Y. Shimizu (National Research Inst. for Metals, Tokyo). IAEA Preprint CN-13/9. 11p. (In English)

To be published in the Proceedings of the IAEA Conference on the Corrosion of Reactor Materials held in Salzburg, 4-9 June 1962.

An investigation was made on the corrosion characteristics of several metals, such as aluminium, zirconium, and stainless steel in polyphenyls. Corrosion tests were carried out using biphenyl, ortho-terphenyl and Santo Wax-R as corrosives, and samples were heated with them at the temperature of 370°C in stainless steel autoclave, pressurized with nitrogen gas to prevent boiling of polyphenyls. The results are summarized as follows: (1) Polyphenyls, which contained about 0.1 to 0.2% water, corroded very seriously aluminium, zirconium, and their alloys, and intercrystalline corrosion of the aluminium, and hydriding of zirconium were found. (2) When the purified polyphenyls containing 200 to 400 ppm water were used, aluminium alloys not containing magnesium showed good corrosion resistance. However, the corrosion resistance of zirconium and its alloys and aluminium alloys with magnesium were not improved by the purification. (3) Oxygen and water vapor in nitrogen gas for pressurizing also caused increase in corrosion of metals. (4) Corrosion products of aluminum alloys containing magnesium were identified to be as MgO by x-ray diffraction method, and Al_2O_3 was not found. This fact suggests that magnesium was preferentially attacked by organics. In the case of zirconium, the corrosion product film was ZrO_2, and hydride was found in the matrix. (5) 18-8 type stainless steel showed good corrosion resistance irrespective of the water and oxygen contents in the environments. (6) Of the three kinds of polyphenyls tested, no difference was found from the standpoint of corrosion. (7) In conclusion, stainless steel is the best material tested, but the aluminium alloys not containing magnesium are also corrosion resistant to polyphenyls provided that the impurities in the environment were properly controlled. (auth)

22548 WORK ON CORROSION OF ALUMINIUM IN WATER AT THE JAPAN ATOMIC ENERGY RESEARCH INSTITUTE. M. Kawasaki, S. Nomura, H. Itami, Y. Kondo, T. Kondo, N. Ito, and C. Akutsu (Japan Atomic Energy Research Inst., Tokyo). IAEA Preprint CN-13/10. 57p. (In English)

To be published in the Proceedings of the IAEA Conference on the Corrosion of Reactor Materials held in Salzburg, 4-9 June 1962.

A large amount of aluminium and aluminium alloys being used in flowing water at temperatures below 100°C in the JRR-2 and JRR-3, dynamic corrosion of aluminium was studied under conditions corresponding to those prevailing in reactors. When commercial grade pure aluminium is corroded in flowing water at 50 to 70°C, the weight of the aluminium specimen increases with time at low flow rates and decrease with increasing flow rate. The change of specimen weight is also affected by water purity and conditions of surrounding atmosphere. The total amount of corrosion from chemical analysis does not always parallel the change of weight of the specimen, and pitting (about 10 microns in diameter) is also observed to occur in many specimens. It can therefore be concluded that corrosion is difficult to estimate only from change of specimen weight. In several cases the relation between the properties of surface oxide film and corrosion reaction in flowing water was established. Some studies on the corrosion mechanism of aluminium and aluminium alloys in hot water and steam were conducted. In hot water, aluminium corrodes with increasing ease with higher purities of the metal, and according to Draley this is due to penetration of hydrogen into the grain boundaries where they evolve into gaseous form. Various methods were used to ascertain the foregoing theory, and in particular hydrogen evolution at the grain boundaries was observed directly in a windowed autoclave. It was also established by x-ray and electron-microscopic methods that transformation and structural change of the surface oxide film modifies the kinetics of corrosion reaction of aluminium in steam around 300°C. (auth)

22549 CORROSION TESTS WITH MOLTEN PLUTONIUM FUELS. B. J. Thamer, R. P. Hammond, R. M. Bidwell, C. C. Burwell, and J. E. Kemme (Los Alamos Scientific Lab., N. Mex.). IAEA Preprint CN-13/12. 49p. (In English)

To be published in the Proceedings of the IAEA Conference on the Corrosion of Reactor Materials held in Salzburg, 4-9 June 1962.

Molten plutonium alloys may combine some of the advantages of fluid fuels with the high breeding ratios that are possible with fast plutonium reactors, but a successful container material is essential to their utilization. Fuel for the Los Alamos Molten Plutonium Reactor Experiment (LAMPRE) is the eutectic of plutonium–iron which has 15 grams of plutonium per cubic centimeter during operation. Development of a container material for this fuel has involved study of mass transfer effects and intergranular corrosion. Accelerated laboratory tests at maximum tantalum: plutonium–iron temperatures of 700 to 800°C showed that 500 to 2000 ppm of carbon in the fuel would reduce mass transfer to a negligible level; similar amounts of silicon or manganese gave lesser benefits. The resistance to intergranular attack was markedly improved by the development of high-purity tantalum, by special fabricating procedures, and especially by annealing of the tantalum at 1200 to 1500°C. Although the addition of small amounts of carbon, silicon, or aluminum to the fuel effectively combatted intergranular attack at 750°C, their benefits were

harder to realize at 625°C. Small amounts (10 to 20 ppm) of calcium and magnesium in the fuel were found to be detrimental to the container. LAMPRE has been in operation for more than one-half year without detectable leakage of fuel. Some of its capsules have been examined metallographically after 4000 hours at 475°C and have exhibited no corrosion. Dilute plutonium alloys may offer the higher specific power required for economic nuclear power. Those of plutonium–cerium with cobalt, copper, nickel, or manganese are manifold less corrosive toward tantalum than the plutonium–iron eutectic. Uranium-rich alloys such as depleted uranium–manganese–plutonium would offer the advantage of internal breeding but certain ceramics hold more promise than tantalum for containment. (auth)

22550 THE CORROSION OF ALUMINUM ALLOYS IN HIGH TEMPERATURE WATER. J. E. Draley and W. E. Ruther (Argonne National Lab., Lemont, Ill.). IAEA Preprint CN-13/14. 35p. (In English)

To be published in the Proceedings of the IAEA Conference on the Corrosion of Reactor Materials held in Salzburg, 4-9 June 1962.

Research and development carried on the high-temperature aqueous corrosion of aluminum alloys, and on strengthening corrosion resistant alloys by powder metallurgy fabrication are described. The results are discussed in three categories. Mechanism Experiments: The corrosion rate of aluminum alloys in the temperature range 260 to 315°C depends on conditions under which the tests are run. In particular, there is a large variation in corrosion rates observed when there is a high rate of flow of water past metal surface. Seemingly minor variations in conditions have caused large changes in corrosion rate. The factors which control corrosion rates under such conditions are discussed in the light of the results of a number of experiments which were designed to elucidate the mechanism. Low-Silicon Alloys: The silicon content of aluminum-nickel-iron alloys is shown to have important influence on their corrosion behavior. Low-silicon alloys are indicated to have certain advantages in corrosion resistance over those with more typical silicon contents. Powder Metallurgy Alloys: The application of corrosion-resistant alloys to reactor systems is limited by the mechanical properties of typical wrought alloys. For this reason, efforts were made to strengthen such materials by dispersion hardening. These efforts are described, and the properties and corrosion resistance of powder metallurgy tubing so far produced in this program are evaluated. (auth)

22551 CORROSION EFFECTS WITH ORGANIC LIQUID REACTOR COOLANTS. W. E. Parkins (Atomics International, Canoga Park, Calif.). IAEA Preprint CN-13/15. 50p. (In English)

To be published in the Proceedings of the IAEA Conference on the Corrosion of Reactor Materials held in Salzburg, 4-9 June 1962.

Recent results were obtained from specimens exposed to the in-pile and out-of-pile environment of the circulating OMRE coolant. These results are compared with those of other tests just completed using agitator-type autoclaves in laboratory experiments. In these autoclave tests the effects of temperature, water content within the organic, fluid velocity, and cover gas were determined for a number of different types of steels, aluminum and aluminum base cermets, magnesium and magnesium base alloys, zirconium and its alloys, and other materials including niobium and beryllium. Rates of chemical attack were measured and, for certain of the materials, changes in mechanical properties as well. Results show that all materials tested are essentially inert to the virgin organic coolants. Corrosion occurs only as a result of the presence of certain impurities. Small amounts of dissolved water produce catastrophic corrosion on magnesium base materials, increase the corrosion rate on aluminum and zirconium base materials, but have essentially no effect on ferrous alloys. The presence of free hydrogen severely affects zirconium alloys, increases the corrosion rate on magnesium base materials, but has very little effect on the ferrous or aluminum base materials. Attempts to protect zirconium alloys from excessive hydriding by cladding with different metals were unsuccessful. Corrosive effects of sulfur and selenium impurities present in the coolant were noted, but no carburization of any materials was observed. In organic reactor systems where steels and aluminum or aluminum base cermets are used for structural and cladding purposes, corrosion rates are sufficiently low under practical reactor operating conditions that there is no danger of loss of integrity due to the removal of material. A more important problem in organic reactors is now recognized to be the difficulty of removing the corrosion products from the circulating coolant in order to prevent the formation of objectionable films on in-core surfaces. Gross corrosion rates of a low carbon steel system were determined by measurements of radioactive species, in particular Mn^{56}, in the OMRE coolant. Similar data were also obtained using the mass of corrosion product removed by the organic coolant purification system. This information showed that corrosion rates were significantly increased when oxygen was permitted to contact the irradiated coolant. The result was the formation of oxygen-containing organic compounds which accelerated the corrosion of the low carbon steel. This effect has very recently been demonstrated in the laboratory, and certain oxygen-containing organic compounds identified. No direct effect of increased corrosion rate due to the presence of radiation was noted. Radiation is indirectly important in that it produces free hydrogen (also produced by pyrolysis of the coolant at high operating temperatures) as well as certain organics which are then capable of reacting with oxygen to form corrosive compounds. (auth)

22552 THE RELATIONSHIP BETWEEN OXYGEN DISTRIBUTION AND CORROSION IN SOME REFRACTORY METAL–LITHIUM SYSTEMS. J. R. DiStefano and E. E. Hoffman (Oak Ridge National Lab., Tenn.). IAEA Preprint CN-13/23. 32p. (In English)

To be published in the Proceedings of the IAEA Conference on the Corrosion of Reactor Materials held in Salzburg, 4-9 June 1962.

An investigation was conducted on tantalum, niobium, vanadium, and zirconium to determine the influence of small amounts of oxygen in these materials on their corrosion resistance. The Nb-O-Li system was studied in some detail and leads to the following conclusions. As the oxygen concentration in niobium increases, its corrosion resistance to lithium decreases. This type of corrosive action by lithium is not a dissolutioning process, but rather involves penetration of the material by lithium and the precipitation of a "corrosion phase." Under the conditions of these tests, the thermodynamic distribution coefficient for the partitioning of oxygen in the system is such that oxygen is also gettered from the niobium by lithium and therefore weight-change data are not indicative of the extent of corrosion. Corrosion is a strong function of both time and temperature and has a deleterious effect on the mechanical properties of the niobium. Studies of polycrystalline nio-

bium specimens indicate that corrosion occurs both intergranularly and transgranularly. The transgranular mode of penetration was found to have a crystallographic pattern. Orientation determinations in single crystal specimens revealed the habit plane of the corrosion product. In an effort to relate oxygen distribution to corrosion, studies of the correspondence between etch pits and edge dislocations in niobium were conducted. The relationship between corrosion and dislocation density was determined. The other systems which were investigated were Zr-O-Li, Ta-O-Li, and V-O-Li. Additions of oxygen to zirconium did not affect its corrosion resistance to lithium; although, when the contamination reached a high level, the oxygen was gettered by the lithium just as in the case of niobium. Corrosion of tantalum and vanadium is shown to be even more sensitive to oxygen contamination than niobium. (auth)

22553 CORROSION IN THE CONCRETE OF NUCLEAR REACTORS. L. Gálvez Crus (Comisión Nacional de Energía Nuclear, Mexico City). IAEA Preprint CN-13/27. 27p. (In Spanish)

To be published in the Proceedings of the IAEA Conference on the Corrosion of Reactor Materials held in Salzburg, 4-9 June 1962.

The physico-chemical properties of the components of concrete used as shielding for nuclear reactors are discussed to determine the causes of corrosion in it. The internal characteristics of the materials used in preparing the concrete are analyzed and an examination made of the external agents which have a decisive effect in the deterioration. The phenomena governing large-scale destruction are studied, i.e., (a) internal reactions between ordinary components and special aggregates; (b) dissolution of products of concrete as a result of electrolytic phenomena; (c) moistening and drying processes (alternation); (d) thermal characteristics of concrete; and (e) effect of the preparation of reinforced concrete on the corrosion of the steel in it. An examination, outside the reactor was made of the causes of deterioration in concrete having the required characteristics. To this end, physical, chemical, and bacteriological analyses were made of the materials and external agents. The results were then correlated and conclusions drawn concerning the causes of corrosion in this particular case. Measures are suggested for avoiding any deterioration from these causes in concrete manufactured from materials available in Mexico for use in nuclear reactors. (auth)

22554 ZIRCALOY-2 AND STAINLESS STEEL CORROSION IN FLOWING WET STEAM. A. Bassi, E. Brutto, G. Camona, G. Imarisio, G. Perona, and R. Sesini (Centro Informazioni Studi Esperienze, Milan). IAEA Preprint CN-13/28. 28p. (In English)

To be published in the Proceedings of the IAEA Conference on the Corrosion of Reactor Materials held in Salzburg, 4-9 June 1962.

The corrosion of Zircaloy-2 and AISI 304 stainless steel in flowing steam–water mixture was measured. Measurements were performed in a loop at temperatures between 240° and 290°C, at specific mass flow rate between 260 and 550 g/cm^2-sec, and at steam quality between 0.3 and 0.65. The test elements were round small-bare tubes; static autoclave tests in water were also performed on the same alloys. The comparison between dynamic corrosion tests in flowing wet steam and static corrosion autoclave tests shows a considerable influence of the specific mass flow rate of the corroding medium on the corrosion rate. The corrosion rate, in flowing wet steam, is always higher than in static water at the same temperature. No erosion was observed up to the maximum specific mass flow rate attained, while, at the high side of the specific mass flow rate interval, the dynamic corrosion law relative to Zircaloy-2 appears very different from the static corrosion law. Some attempts are given in order to explain the unusual corrosion behavior of Zircaloy-2 in the new corroding medium while further measurements are in progress in order to reach a better insight about this fact. The corrosion facility and the measurement procedure are briefly described. The data are given in graphs as weight gain versus time or weight gain versus temperature. (auth)

22555 CORROSION STUDY OF HFR ALCLAD HEAT EXCHANGER TUBING IN BRACKISH SECONDARY COOLANT. J. J. M. Snepvangers, B. Verkerk, and J. Beijer (Reactor Centrum Nederland, Petten, Netherlands). IAEA Preprint CN-13/34. 12p. (In English)

To be published in the Proceedings of the IAEA Conference on the Corrosion of Reactor Materials held in Salzburg, 4-9 June 1962.

In the heat exchangers for the RCN high flux reactor, various aluminium alloys were applied. For all parts in contact with the secondary coolant (brackish water with varying salt content), Alclad materials were chosen. In order to gain an insight in the behavior of the internally clad tubes (Alclad 3003), and to predict the useful life of the coolers, a series of technological tests was performed. In these tests, secondary coolant was circulated through a series of sample tubes under the same conditions of temperature and flow as prevail during normal reactor operations. Test runs were performed for periods ranging from three months to over a year. Sample tubes showed pitting corrosion rather than a uniform attack, as is claimed in some cases. Results are not consistent in so far that some of the tubes showed a much heavier attack than others. From metallographic examination, it appeared that pits never penetrated the underlying material even when the diameter of the pits was fairly large in comparison with the thickness of the clad layer. To check the extent of protection, a sample was run in which 80% of the clad layer was deliberately removed by machining grooves in the tube. A few pits were observed in the remaining clad layer, but the base material showed no visible attack. In the actual heat exchangers, the tubes are fastened to the end plates by a rolling operation. Test pieces prepared in the same way showed similar damaging effects due to cold work as the tubes in the heat exchangers themselves and also showed a tendency to enhanced corrosion. The results of the tests give one a reasonable confidence that the heat exchangers will give satisfactory performance with an estimated life expectancy for the tubes of three to five years. (auth)

22556 COMPATIBILITY OF STRUCTURAL STEELS WITH CARBON DIOXIDE GAS UNDER PRESSURE AT AVERAGE TEMPERATURES. R. Darras, D. Lecleroq, and H. Loriers (Centre d'Études Nucléaires, Saclay, France). IAEA Preprint CN-13/39. 26p. (In French)

To be published in the Proceedings of the IAEA Conference on the Corrosion of Reactor Materials held in Salzburg, 4-9 June 1962.

The corrosion resistance of a number of slightly alloyed steels in the presence of carbon dioxide gas under a pressure of between 450 and 550°C was studied with a view to the possibility of their use as component materials in the hot gases circuit of the EL.4 reactor. At first, two conventional grades (0.5% Cr–0.5% Mo and 2.25% Cr–1% Mo) were considered. With the first, corrosion is sometimes disastrous from 450°C and (depending on the lot of samples taken) results vary very widely. The second is definitely

less affected, even up to 550°C. Like most slightly alloyed steels, however, the attack in both grades as revealed by the appearance of excrescences on the surface of the oxide is irregular between 450 and 550°C. The presence of carbon monoxide in the carbon dioxide gas appears to enhance this phenomenon. Until it reaches some 10%, an increase in the chromium content of the steel does not result in any improvement. In the case of intermediate concentrations, the surface defects persist and the adherence of the oxides is unsatisfactory. From the point of view of corrosion, the addition of aluminium or silicon seems beneficial but some of the resulting grades are fragile in the cold state. A steel containing 2% Cr, 0.3% Mo, and 0.5% Al seems to be especially promising, as regards both its corrosion resistance and its creep characteristics, which are higher than those of steel containing 2.25% Cr and 1% Mo. (auth)

22557 THE EFFECT OF COMPOSITION OF WATER ON CORROSION OF ZIRCONIUM ALLOYS AT HIGH TEMPERATURES AND PRESSURES. I. L. Rosenfeld, Yu. P. Olkhovnikov, and A. A. Sudarikova. IAEA Preprint CN-13/42. 21p. (In Russian)

To be published in the Proceedings of the IAEA Conference on the Corrosion of Reactor Materials held in Salzburg, 4-9 June 1962.

The effect of the content of F'^{-}, Cl'^{-}, SO_4^{-2} and CO_3^{-2} anions in reactor cooling water on the corrosion of zirconium alloys (zirconium-lead-iron-nickel-niobium and zirconium-niobium systems) at high temperatures (360°C) is described. Kinetic curves are drawn for the relationship between corrosion and the time factor and for the logarithm of concentration of the particular anion. Reaction rate constants are also calculated. It is shown that the zirconium alloys have high corrosion resistance in pure distilled water at a temperature of 360°C. However, the presence in the water of even insignificant concentrations of certain ions, which under normal conditions would be absolutely harmless, induces intensified corrosion of zirconium alloys at high temperatures. On the other hand, certain anions, which under normal conditions act as activators, have practically no effect on the corrosion of zirconium alloys at the temperatures in question. In connection with this factor, the anion content in the reactor cooling water should be strictly regulated. The varying nature of the effect of the anions is connected with their influence on the characteristics of the protective films formed. (auth)

22558 THE BEHAVIOUR OF ALLOY STEELS IN BICARBONATE SOLUTIONS. THE EFFECT OF CHLORINE AND OXIDANTS. C. Vanleugenhaghe, L. Klimzak-Mathieu, J. Meunier, and M. Pourbaix (CEBELCOR, Brussels). IAEA Preprint CN-13/43. 53p. (In French)

To be published in the Proceedings of the IAEA Conference on the Corrosion of Reactor Materials held in Salzburg, 4-9 June 1962.

An electrochemical study was made of the factors favoring or inhibiting localized corrosion in various samples of two 18/8 chrome-nickel alloy steels (AISI 304 and 316) and of one chrome alloy steel (AISI 410) in contact with sodium bicarbonate solution (0.10 M at 20°C) containing varying quantities of sodium chloride. The influence of surface state and heat treatment on corrosion factors in these steel samples was studied. On the basis of the conceptions of "breakthrough potential" (Brennert) and "protection potential" general criteria were deduced for determining under what conditions oxidizing or reducing action can cause or inhibit localized corrosion in these steels. The validity of the findings was checked by corrosimetric and corrosiscopic studies involving examination of the effect of oxidants (hypochlorite, permanganate, hydrogen peroxide, oxygen) and of anodic and cathodic polarization on the behavior of the steels in contact with chlorinated bicarbonate solutions. This study yielded the following conclusions: There exists a critical chloride content, below which no corrosion of the steel is possible (at least at electrode potentials lower than those at which decomposition of the water occurs with liberation of oxygen), irrespective of whether the solution contains an oxidizing agent or not; this critical chloride content depends on the nature of the steel, on the heat treatment it has undergone and on its surface state. The following critical chloride contents were obtained for the steel samples examined: 410 steel: 0.24 to 0.53 g Cl^-/l, 304 steel: 0.58 to 1.04 g Cl^-/l, 316 steel: 0.62 to [illegible] g Cl^-/l. The content of 24 g/l, which is relatively very high, relates to a sample of 316 steel wire, subjected to industrial heat treatment and electrolytic polishing. When the chloride content of the solution exceeds the critical content, there is a risk of localized corrosion. Such corrosion, however, can only occur in the presence of an oxidizing agent or of an anodic electric current capable of raising, even temporarily, the electrode potential of the steel above the critical potential. This critical electrode potential, which is the break-through potential, can be used for quantitatively defining the resistance of a given sample of alloy steel to the action of a given chlorinated solution: the higher the breakthrough potential, the less the risk of corrosion. In the presence of solutions of 0.10 M $NaHCO_3$ and 0.60 M NaC_1 (21 g Cl^-/litre) at 20°C, the following range of break-through potential values (referred to the standard hydrogen electrode), was obtained, varying according to heat treatment and surface state: 410 steel: +50 to 320 mv, 304 steel: +170 to 670 mv, 316 steel: +360 to more than 1160 mv. Determination of break-through potential can be of great assistance in deciding what heat or surface treatments should be carried out on a given sample of alloy steel in order to increase its resistance to localized corrosion in the presence of a particular solution; determination of the potential can thus also help in the development of other corrosion-resistant steels and alloys. The following values are different critical contents of oxidant found for 410 steel in the form of wire, with its original heat treatment and surface state, in the presence of a solution of 0.10 M $NaHCO_3$ and 0.6 M NaCl (21 g Cl^-/l) at 20°C: 0.10 to 0.18 mg $KMnO_4$/l, 18 to 32 mg NaClO/l. Whatever the contents of oxidant and chloride in a 0.10 M sodium bicarbonate solution, an alloy steel can be protected against all risk of corrosion from this solution by a treatment which maintains its electrode potential below a certain critical value, termed protection potential; like the break-through potential, this protection potential depends on the chloride content of the solution, the nature of the steel, its heat treatment and its surface state. A judicious cathodic protection of these steels can therefore protect them fully against corrosion or against the further development of any already existing corrosion. (auth)

22559 THE ELECTROCHEMICAL DETERMINATION OF CORROSION RATES OF METALS USING CYCLIC CURRENT STEP POLARIZATION. P. J. Gellings (N. V. Werkspoor, Amsterdam). IAEA Preprint CN-13/44. 9p. (In English)

To be published in the Proceedings of the IAEA Conference on the Corrosion of Reactor Materials held in Salzburg, 4-9 June 1962.

It is shown that the application of cyclic current step polarization of a corroding metal leads to the possibility of establishing the corrosion rate. The theory of this method is discussed and the necessary conditions stated.

This method may be applied to test coupons (or even the reactor material itself) without the need of removing these coupons for inspection or measurements. (auth)

22560 THE CORROSION OF ZIRCALOY IN VARIOUS ALKALINE MEDIA AT HIGH TEMPERATURE. H. Coriou, L. Grall, J. Meunier, M. Pelras, and H. Willermoz (Centre d'Études Nucléaires, Saclay, France). IAEA Preprint CN/13/46. 21p. (In French)

To be published in the Proceedings of the IAEA Conference on the Corrosion of Reactor Materials held in Salzburg, 4-9 June 1962.

It is current practice in pressurized-water reactors to raise the pH of the water. The purpose of this is to make the corrosion products more easily filterable and so to reduce considerably the contamination of the circuits. A study was made to define the limits of the various possible alkaline media. The tests were carried out in solutions of lithia and ammonia with concentrations up to 10 and 3 g/l respectively. It was observed that in lithia solutions at 360°C, the Zircaloy undergoes very rapid corrosion for lithia concentrations above a "critical threshold" in the neighborhood of 2 g/l, while below this threshold there is no appreciable effect. By way of example, the increase in weight after three days in multiplied by a factor of 100 if the concentration is increased from 2 to 5 g/l. The critical threshold is greatly influenced by temperature, rising from 0.5 to 5 g/l if the temperature rises from 330 to 370°C (duration of tests: 3 days). At 300°C, the critical threshold is still not reached for concentrations of 10 g/l. At the same time the existence of a marked crevice effect was demonstrated. Even in lithia solutions with a concentration well below the critical threshold two samples of Zircaloy pressed together can undergo very serious corrosion at the faces in contact. For example, after three days testing in a lithia solution at 360°C, pH 11, the contact faces of certain specimens had undergone corrosion about ten times greater than that in non-contacting control specimens treated in the same conditions. This phenomenon is also found, but to a lesser degree, if the Zircaloy is placed in contact with stainless steel. In solutions of ammonia, the Zircaloy behaved normally in all the cases investigated and no crevice effect was noted. An explanation of these crevice effects is proposed. (auth)

22561 RESISTANCE TO CORROSION OF AUSTENITIC AND FERRO-PERLITIC STEELS IN A STREAM OF LIQUID SODIUM AT TEMPERATURES OF 600°C AND 700°C. V. S. Lyashenko, V. V. Zotov, and V. A. Ivanov. IAEA Preprint CN-13/50. 17p. (In Russian)

To be published in the Proceedings of the IAEA Conference on the Corrosion of Reactor Materials held in Salzburg, 4-9 June 1962.

Results are given of experimental work on the resistance to corrosion of various constructional materials in a stream of liquid sodium at temperatures of 600 and 700°C. The experiments were continued for 6500 hours in dynamic loop conditions. The following austenitic steels were submitted for experiment and investigation: "1Kh18N9T", "OKh15M3B", "OKh12N16S4B", "1Kh14N20V2B", "1Kh14N15B", OKh20N14S2", 1Kh15N36V3B", "1Kh14N-14S4B". Results are given for three ferro-perlitic steel types: "2Kh13MBS", "1Kh12MVF", 2Kh12MVBF". After the experiment in sodium containing 0.004 to 0.006 wt % of oxygen, the austenitic and the ferro-perlitic steels both had a relatively high combination of mechanical qualities. However, some ferro-perlitic steels tended to have a partial carbon loss when used in conjunction with austenitic steels. The nature of the interaction of the steels with sodium and the changes occurring in their microstructure following prolonged operation both with sodium and in the absence of a medium are analyzed. Results are also given of experiments with various steels in a stream of impure sodium containing 0.02 to 0.04 wt % of oxygen and the results of using calcium as an inhibiting addition to the sodium. The data indicate that, in isothermic conditions, the addition of 0.2% of calcium to the sodium significantly lowers the latter's corrosion attack on austenitic steels. (auth)

22562 SOME ASPECTS OF THE THEORY OF CORROSION OF REACTOR MATERIALS IN CRITICAL-PARAMETER WATER. V. V. Gerasimov. IAEA Preprint CN-13/51. 16p. (In Russian)

To be published in the Proceedings of the IAEA Conference on the Corrosion of Reactor Materials held in Salzburg, 4-9 June 1962.

Autoclave studies of the kinetics of electrode processes at temperatures up to 300°C and pressures up to 87 atm showed that, in critical-parameter water, corrosion of low-alloy chrome and chrome-nickel stainless steels and aluminium alloys has an electrochemical character. Normally, the anode polarization curves show areas—both passive and over-passive—of active dissolution of the metal. Under stationary potential conditions in a neutral medium the rates of the cathode processes, oxygen ionization, and hydrogen ion discharge are commensurate. Increase in the oxygen concentration in the water, without affecting the kinetics of the anode process in the substances under investigation, results in an increased cathode process rate and a shift of potential towards the positive. Accompanying the movement of the anode polarization curve, the rate of corrosion of low-alloy steel comes to its maximum with an increase in the oxygen content of the medium. Since 18-8 type stainless steel under stationary potential conditions is in the passive state, increase in the oxygen content of the water and change of the pH from 3 to 12 have only a slight effect on the resistance of the steel. It was shown that inhibition of corrosion of metals is not connected with the presence or absence of oxygen in the medium. At certain potentials chlorine ion participates directly in the anode process. Elementary chlorine is formed, together with chloric and hypochlorous acids, and the metal comes out of the passive state. Since chloric and hypochlorous acids are good depolarizers, the corrosion rate of the metal rapidly increases. The effect of sulphates, carbonates and corrosion products, both in solution and on the metal surface, on the kinetics of electrode processes and on the resistance of structural materials is also considered. The effect of neutron irradiation on the kinetics of electrode processes and on corrosion resistance of 1X18N9T steel in water saturated with oxygen and nitrogen was also investigated. Irradiation does not change the kinetics of the anode process but increases the rate of the cathode reaction. Since, in high-purity water at room and critical temperatures, 1X18N9T steel is in the passive state at standard potential, irradiation does not increase the corrosion rate. The data obtained make it possible to forecast the corrosion behavior of structural materials at critical temperatures in water of any composition. (auth)

Fabrication

22563 (DC-61-6-29) EVALUATION OF IRON–CHROMIUM–YTTRIUM ALLOYS FOR SERVICE TO 2300°F. Supplementary Close-Out Report for Job 54376.

J. F. Collins, N. McConnaughey, and F. E. Walker (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). June 6, 1961. Contract AT(11-1)-171. 17p.

Iron-35 wt % Chromium-1 wt % yttrium alloy was melted, extruded to rod, and evaluated. A total of 1100 pounds of useful ¾ in.-diameter rod was produced. A recommended melting procedure is outlined. Chemical analyses are described, and oxidation test data at 2300°F are presented. The effects of surface condition and various treatments on oxidation life were studied. It was concluded that heats of the alloy up to 300 lb can be made on a reproducible basis, which as 0.020 in. sheet will resist destructive oxidation for more than 1200 hr in 2300°F air. (auth)

22564 (DMIC-Memo-153) BRAZING AND BONDING OF COLUMBIUM, MOLYBDENUM, TANTALUM, TUNGSTEN, AND GRAPHITE. H. E. Pattee and R. M. Evans (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). June 11, 1962. Contract AF 33(616)-7747. 25p.

Brazing processes and diffusion and solid-state bonding methods for graphite, molybdenum, niobium, tantalum, and tungsten are summarized. Properties which are important in aerospace applications are discussed. Typical filler metals used to join the refractory materials for low-temperature as well as high-temperature service conditions are covered. Brazing methods for particular systems are briefly discussed. (N.W.R.)

22565 (NLCO-849) CONSUMABLE-ELECTRODE ARC-MELTING OF URANIUM. H. M. Eikenberry and T. D. Nixon (National Lead Co. of Ohio, Cincinnati). June 15, 1962. Contract AT(30-1)-1156. 35p.

A small-scale, arc-melting feasibility study was completed. Two-inch-diameter electrodes were prepared from both ingot and dingot uranium. These electrodes were then arc-melted under vacuum into 4-inch-diameter ingots. Some of these ingots were re-formed into electrodes and arc-melted a second time. Procedures for the arc melting of uranium were established, and the effects of the process on impurities in uranium were determined. Metallographic studies showed that the inclusions were finely divided and evenly distributed. Chemical analyses indicated that the concentrations of a number of the impurities in uranium are reduced by arc melting. (auth)

22566 (NP-11777) REFERENCES TO ELECTRON BEAM WELDING AND MACHINING 1957–1961. T. D. Stephens, comp. — P. M. Knowlson, ed. (British Welding Research Association, London). Sept. 1961. 10p.

An annotated bibliography is presented on electron beam machining and welding techniques, developments, equipment, and uses. A list of firms manufacturing electron beam welding equipment together with some known users is also supplied. (N.W.R.)

22567 (ORNL-TM-220) COATING OF UO_2 PARTICLES WITH BeO BY SOLUTION METHODS. W. J. McDowell (Oak Ridge National Lab., Tenn.). May 9, 1962. Contract [W-7405-eng-26]. 15p.

Spherical particles of beryllium oxide containing and enclosing UO_2 particles (~10 micron) were prepared by dispersing a suspension of UO_2 in a concentrated viscous solution of a basic beryllium salt in a liquid organic medium, drying, and firing. The spheres produced were porous and would require densification to make the beryllium oxide protective to the UO_2. Precipitation of beryllium hydroxide or carbonate on UO_2 particles suspended in solutions of beryllium salts under various conditions produced no actual coating of the UO_2 particles. (auth)

22568 (ORO-552) HELICAL FINNED TUBE DEVELOPMENT QUARTERLY REPORT, JANUARY 16, 1962. TO APRIL 15, 1962. Technical Report No. 258-235. E. A. Murphy and J. G. Klein (Brush Beryllium Co., Cleveland). Apr. 15, 1962. Contract AT(40-1)-2912. 23p.

Progress in the development of a process for the production of helical finned beryllium tubing by warm extrusion and drawing techniques is described. (auth)

22569 (ORO-557) HELICAL FINNED TUBE DEVELOPMENT. [Progress Report], April 16, 1962–May 15, 1962. E. A. Murphy and J. G. Klein (Brush Beryllium Co., Cleveland). Contract AT(40-1)-2912. 6p.

Tests were made of Be finned tubing produced by the "A" die design. Results are given for visual inspection, helium leak test, burst tests, and x-ray diffraction study of grain orientation. (T.R.H.)

22570 (XDCL-60-5-131) FABRICATION AND PROCESSING OF BERYLLIDES AT GE-ANPD. D. A. Mannas (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). May 1960. Contract AT(11-1)-171. 12p.

Improved techniques were developed for the fabrication of beryllides by the conventional vacuum hot pressing process, and a broad investigation of the application of other fabricating processes was initiated. In the vacuum hot pressing process the limited purity of the base materials restricts the ultimate purity of the product. Extrusion, arc melting and casting, and induction melting and casting are discussed. (M.C.G.)

22571 (AEC-tr-5083) SINTERING OF URANIUM OXIDE IN HYDROGEN AT 1350°C. A. Bel, R. Delmas, and B. François. Translated from J. Nuclear Materials, 1: 259-70(1959). 19p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract no. 4378.

22572 *VACUUM BRAZING OF STAINLESS STEEL TO* BERYLLIUM. Everette M. Whitson (Univ. of California, Livermore). Metal Progr., 82: No. 1, 93-5(July 1962). (UCRL-5999)

A new technique of brazing stainless steel to beryllium results in vacuum-tight joints twice as strong as those previously obtained. Pretreatment of the component surfaces, as well as the brazing operation itself, is done in a furnace capable of maintaining a vacuum of 0.1 μ. (auth)

Properties and Structure

22573 (AD-266459) THERMODYNAMIC INVESTIGATION OF CERAMIC MATERIALS AT ELEVATED TEMPERATURES. Quarterly Report, June 15, 1961 to September 15, 1961. Michael Hoch (Cincinnati. Univ. Research Foundation). Nov. 6, 1961. Contract AF33 (616)-6299. 10p.

Structures investigated were FeO, TiO, VO, and NbO (all NaCl structure). They belong in 2 groups: One group is FeO where only iron vacancies are present. The other group is TiO, VO, and NbO where both anion and cation vacancies can be found. In both groups the concentration of vacancies is quite large. First, mathematical expressions for the interaction energy between vacancies were derived. In the compounds investigated, the defects occurred only as vacancies exhibited by both components. The grand partition function for a crystal with only vacancies present is presented. (auth)

22574 (AD-269425) A PHASE STUDY OF A SELECTED PORTION OF THE Ti–Al–Zr TERNARY SYS-

TEM INCLUDING LATTICE PARAMETER DETERMINATIONS FOR THE Ti–Al γ PHASE (thesis). Doral Randolph Sandlin and Henry Albaum Klung, Jr. (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio). Aug. 1961. 131p. (GAW/Mech-61-6)

The γ phase of the Ti–Al binary system is of interest because it exists as a single phase up to its melting temperature (1460°C) and has been shown by the Armour Research Foundation to have good strength to very high temperatures. However, the brittleness of the γ phase, which is believed to be caused by its ordered face-centered tetragonal crystal structure, has discouraged its development as an elevated temperature material. It is believed that if the c/a ratio of the crystal structure could be lowered and the ordering destroyed, the brittleness would be reduced. Previous investigators have reported a lowering of the c/a ratio to 1.006 at 15% zirconium and predicted a c/a ratio of unity at 20% zirconium in the γ phase. This investigation was conducted to determine if the c/a ratio of unity could be obtained. Data obtained are compared with data from which the c/a ratio of unity was predicted. The conclusions that are drawn from this comparison are that the c/a ratio of unity can not be obtained as predicted, and that phases other than the γ phase are present in alloys at which his prediction was made. Coincident with the lattice parameter determinations, a study was made of the presence of phases in the region of the Ti–Al–Zr ternary system between 45 and 55 atomic percent aluminum. Two, and possibly three, new phases are observed, but their identification was not undertaken. The results of the phase investigation are given. (auth)

22575 (AD-270842) STUDY OF THERMAL PROPERTIES OF REFRACTORIES. Quarterly Progress Report No. 1. R. E. Taylor and M. M. Nakata (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 1961. Contract AF33(657)-7136. 19p. (AI-6829)

An attempt is being made to measure, describe, and understand the thermal properties of refractory materials from ambient temperature to temperatures approaching the melting point. The development of transient thermal property is described. Modifications and improvements of the apparatus are described, and results of measurements of the thermal diffusivity of Ta at 1400 and 1500°C are given. The status of thermal property measurements by existing techniques is also included. (auth)

22576 (AERE/X/PR-2506(May '59)) CARBIDES OF THORIUM AND URANIUM IN BISMUTH. Report No. 13,312C. A. Chitty and D. R. Slade (General Electric Co., Ltd. Research Labs., Wembley, England). May 1, 1959. For United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England. Contract 6/ATOMIC/155. 12p.

Monocarbides and dicarbides of uranium and thorium were produced by arc melting techniques. The compounds were agitated with liquid bismuth at 500°C and the reaction products studied by metallographic and x-ray techniques. Uranium monocarbide and uranium dicarbide are stable in liquid bismuth but thorium monocarbide reacts with bismuth to form the more stable compound, thorium bismuthide. The results for thorium dicarbide in liquid bismuth are inconclusive as it has not yet been found possible to produce homogeneous thorium dicarbide by arc melting. (auth)

22577 (ARF-2231-4) PILOT EVALUATION OF VANADIUM ALLOYS. Bimonthly Report No. 4, March 18, 1962–May 17, 1962. B. R. Rajala and F. C. Holtz (Illinois Inst. of Tech., Chicago. Armour Research Foundation). June 15, 1962. Contract NOw-62-0101-c. 15p.

Some twenty high-vanadium and V-60 wt % Nb base alloys containing refractory metal and interstitial additions were fabricated by hot and cold rolling techniques. All compositions were rendered to 0.050 inch sheet except those containing molybdenum or more than 0.13 wt % combined oxygen and nitrogen. Tensile results at 2400°F showed that V-20 wt % Nb base materials had ultimate tensile strength values in the 8,000 to 10,000 psi range, whereas V-60 wt % Nb base alloys had strengths of 12,000 to 19,000 psi. Additions of 0.05 wt % oxygen or 0.03 wt % each of oxygen and nitrogen produced large strength increases in the V-60 wt % Nb base. A 100-pound ingot of V-1Ti-60 Nb was melted for extrusion and subsequent fabrication into bar, plate, and sheet for more detailed property evaluations. (auth)

22578 (AROD-618:23) STUDY OF THE ALLOYS OF TRANSITION ELEMENTS. Final Report, 1953–1961. Paul A. Beck (Illinois. Univ., Urbana. Coll. of Engineering). Contract DA-11-022-ORD-1175. 7p. (AD-266280).

Efforts were devoted to the investigation of the occurrence and composition ranges of various intermediate phases in binary and ternary alloys of transition elements, concentrating on phase diagrams. Quantitative information was also gathered on the physical properties of these alloys such as magnetic susceptibility, saturation moment, low- and high-temperature specific heat, and electrical resistivity. (auth)

22579 (AROD-1931:3) THE ORDER DEPENDENT THERMAL RESISTIVITY OF Cu_3Au. Final Technical Report. Part III, January 22, 1958 to January 21, 1961. Robert Cotellessa, Samuel D. Lindenbaum, and S. L. Quimby (Columbia Univ., New York). May 1, 1962. Contract DA-30-069-ORD-2195. 37p.

Modifications of an earlier apparatus for the measurement of thermal resistivity are described which permit long anneals and rapid quenches of the specimen in situ. Measurements of the variation of thermal resistivity at equilibrium order between 220 and 410°C, and also following rapid quench from various higher temperatures to 220°C, are reported. It is found that the order dependent change in thermal resistivity varies linearly with the order dependent change in lattice constant at temperatures below the critical temperature for ordering. Thus, the measure of order governing the order dependence of lattice constant, Young's modulus of elasticity, and electrical and thermal resistivity is very nearly, if not exactly, the same measure for all four. (auth)

22580 (AROD-2090:1) CORRELATION OF THERMAL FATIGUE WITH MEAN TEMPERATURE AND INFLUENCE OF COMBINED STRESSES. Final Report, June 1, 1958–February 28, 1962. Harry Majors, Jr. (Seattle Univ., Seattle). Mar. 1962. Contract DA-04-200-ORD-785. 101p.

The results of a literature survey are given along with the methods used and the results obtained for studies on thin-walled tubes, of type Ti-75A titanium where rm/t equals 13, under nonsinusoidal, pulsating direct stress at several constant mean temperatures. The range of thermal-strain fatigue cycling was from 8,000 to 300,000 cycles and the mean temperature ranged from 480 to 880°F. The temperature range varied from 700°F at a mean of 480°F to 275°F at a mean of 880°F. Under these conditions there was no thermal buckling, but some local distortions occurred at a mean temperature of 880°F; and tangential growth was observed on the pressurized tubes, the creep rate increasing with mean temperature. (auth)

22581 (AROD-2530:1) THE STRENGTHENING OF COLUMBIUM AND COLUMBIUM ALLOYS BY INTERSTITIAL ALLOYING ELEMENTS. F. V. Lenel, L. J. Regitz, and W. R. Hulsizer (Rensselaer Polytechnic Inst., Troy, N. Y.). May 11, 1962. Contract DA-30-069-ORD-3868. 109p.

Solid solutions of oxygen in niobium were prepared at 1250°C, cooled rapidly to retain all the oxygen in supersaturated solution, and subjected to isothermal precipitation heat treatments at 650 and 705°C, in a high vacuum. The course of precipitation was followed through measurement of the lattice parameter of the matrix and, in some specimens microhardness measurements. The morphology of the precipitate was determined metallographically. At 650°C, equiaxed NbO precipitate particles were nucleated at the intersections of grain boundaries with free surfaces. At 705°C, in addition to these sites, particles nucleated at grain boundaries and grain boundary intersections throughout the matrix. In all cases, growth of the precipitate was continuous, in that an equilibrium oxygen concentration was approached, by the matrix, without the formation of metastable intermediate solutions or precipitates. The rate of decomposition was strongly dependent on the supersaturation of the solid solution. In specimens supersaturated 1.50 a/o decomposition was first detected after 2 hours at 650°C and after 0.5 hour at 705°C. Decomposition was essentially complete after 8 hours at 650°C and after 40 hours at 705°C. Specimens 0.85 a/o supersaturated began to decompose after 20 hours at 650°C and after 10 hours at 750°C. At this degree of supersaturation decomposition was not completed at either 650 or 705°C within 100 hours, which was the longest period of precipitation heat treatment used in this investigation. (auth)

22582 (ASD-TDR-62-7) RESEARCH TO DETERMINE THE COMPOSITION OF DISPERSED PHASES IN REFRACTORY METAL ALLOYS. Frank B. Cuff, Jr. (Advanced Metals Research Corp., Somerville, Mass.). Apr. 1962. Contract AF33(616)-7671. 60p.

The composition, structures and lattice parameters of the precipitates in two Mo-base and two Nb-base alloys were determined using the electron microbeam probe and x-ray and electron diffraction techniques. In general the precipitates were found to be complex carbides which, in some cases, could be explained on the bases of known phase relationships and thermodynamic data. The deviations of lattice parameters from those of pure carbides could be explained on the basis of atom substitution. (auth)

22583 (BM-RI-6004) RADIOISOTOPES AS TRACERS IN VOLATILIZATION STUDIES OF SELENIUM AND TELLURIUM. J. V. Batty, A. M. Poston, Jr., and H. L. Gibbs (Bureau of Mines, Salt Lake City Metallurgy Research Center). July 1961. 12p.

Selenium-75 and Te^{123} were successfully employed as tracers in metallurgical research for developing an improved method for volatilizing the elements from low-tenor raw materials. Methods were devised and evaluated for admixing the radioactive tracer with typical raw materials and then following the deportment of the selenium and tellurium by radiometric methods with occasional chemical analysis checks. Both radioisotopes followed the same volatilization patterns and were effective tracers for following the deportment of the natural isotopes in the ores, for finding Se and Te that apparently was lost, and for obtaining fast and reliable quantitative analyses. An improved analysis method for Te remaining in fused residues was also developed. (P.C.H.)

22584 (DC-61-2-4) [HIGH TEMPERATURE FRICTION AND WEAR STUDIES]. Milestone I, Task 434311, Job 51146. C. F. Zapf (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Jan. 27, 1961. Contract AT(11-1)-171. 29p.

The results and conclusions of the first half of the program "High Temperature Friction and Wear Studies" are presented. A survey was made of testing and application techniques considered for use in air over the temperature ranges 70 to 1200 and 70 to 1600°F. As a result of this study the second half of the program will concentrate on the utilization of hard materials such as cermets and ceramics to be used in conjunction with themselves and softer structural materials that have a lubricant supply held in surface cavities. (auth)

22585 (DC-61-6-4) SUMMARY OF THERMAL EXPANSION AND THERMAL CONDUCTIVITY MEASUREMENTS BY LEXINGTON LABORATORIES. E. S. Fitzsimmons (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). May 1961. Contract AT(11-1)-171.

Measurements were made of the thermal conductivity and thermal expansion of BeO, ZrO_2 stabilized with Y_2O_3, and Y_2O_3. Thermal conductivity results are somewhat lower than data reported previously. Thermal expansion values for BeO and stabilized ZrO_2 are also lower than results given previously. (auth)

22586 (DMIC-Memo-150) COMPILATION OF TENSILE PROPERTIES OF HIGH-STRENGTH ALLOYS. J. E. Campbell (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Apr. 23, 1962. Contract AF33 (616)-7747. 46p.

Tensile properties of high-strength alloys and beryllium from −423 to 4000°F are presented. The upper limits of the yield strength to density ratios for these alloys within the range of possible service temperature are illustrated. The temperature and time effects are combined in the Larson-Miller parameter for 0.2% offset yield strength or 0.2% plastic creep strain for limited creep data. The time for 0.2% offset yield strength determination is assumed as 0.01 hour. Materials reported on include beryllium, steel, stainless steel, sintered aluminum product alloys, and alloys of aluminum, cobalt, iron, magnesium, molybdenum, nickel, niobium, tantalum, titanium, and tungsten. (N.W.R.)

22587 (GA-3076) A PROGRAM OF BASIC RESEARCH ON MECHANICAL PROPERTIES OF REACTOR MATERIALS. Quarterly Progress Report for Period Ending March 31, 1962. T. A. Trozera, R. H. Chambers, and J. L. White (General Atomic Div. General Dynamics Corp., San Diego, Calif.). May 1, 1962. Contract AT (04-3)-167. 24p.

Studies were continued on the deformation and fabrication characteristics of reactor materials. Data were gathered on the effect of cold work on the internal friction due to dislocation relaxation oscillation. An interpretation was made of the internal-friction peak in niobium in terms of the relaxation motion of kinks on dislocations in niobium. Efforts were made to extend the technique of quantitative differential thermal analysis to cold-worked iron which was selected as the most readily treated representative of the body-centered-cubic structural metals. Refinements were made in the calorimetric technique itself, leading to an improved procedure of data reduction. Results for the effects of grain size on the stored-energy-release spectra of high-purity copper were recomputed. (M.C.G.)

22588 (HW-67811) THE ROLE OF THE OXIDATION RATE ON THE HYDRIDING OF ZIRCALOY-2 BY GASEOUS HYDROGEN. Interim Report No. 3. D. W. Shannon (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 15, 1960. Contract AT(45-1)-1350. 16p.

Work was carried out to determine the amount of water vapor required to inhibit the gaseous hydriding of Zircaloy-2. The oxidation rate of Zircaloy-2 was found to be independent of H_2O pressure. However, the oxidation rate could be slowed by limiting access of water molecules to the metal surface. It was found that in every case where gaseous hydriding was observed, the oxidation rate was slowed below its normal rate due to the experimental conditions. Hydriding was never observed when the oxidation rate was normal. It was concluded the safest atmosphere for Zircaloy-2 at 400°C (or below) is an atmosphere that will supply water (or oxygen) to the metal surface at a rate required to maintain the oxidation rate normal for that temperature. The water concentration of the bulk gas is important only to the extent that it contributes to the rate of transport of water to the metal surface. When the oxidation rate falls below the normal rate, the extent of hydriding will depend on how rapidly reaction sites become available to the hydrogen, the diffusion rate of hydrogen through the oxide, the hydrogen pressure, the mass of metal present, the temperature, and the temperature gradient in the metal. If enough water is present to maintain the normal oxidation rate, the hydrogen pressure should be relatively unimportant. This is indicated by the available data. (auth)

22589 (KAPL-M-EEB-6) TENSILE AND SHEAR TESTS AT ROOM TEMPERATURE. Report No. 1. E. E. Baldwin and F. W. Wiesinger (Knolls Atomic Power Lab., Schenectady, N. Y.). Nov. 25, 1953. Contract W-31-109-eng-52. 14p.

Tensile and shear tests were made on frozen sodium at room temperature using a protective atmosphere of mineral oil. It was found that the sodium was very ductile and that the ultimate shear strength and ultimate tensile strength were extremely sensitive to strain rate. (auth)

22590 (NAA-SR-Memo-7005) REMOTE DENSITY MEASUREMENT OF UO_2 PELLETS. J. Guon, F. W. Gandolfo, R. J. Sullivan, and D. E. Stanwood (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Jan. 9, 1962. Contract [AT(11-1)-Gen-8]. 11p.

Three pieces of equipment for determining geometric and gas density of sintered UO_2 pellets were incorporated in a refabrication cart. A 1200-g capacity balance was modified for remote use. Short-term reproducibility over the entire range was ±0.05 g. A dial depth gauge was modified to read maximum diameter and maximum length of $\frac{3}{8}$ in. dia × $\frac{3}{8}$ in. long pellets to an accuracy of ±0.002 in. A gas pycnometer was developed to determine volumes of high density UO_2 pellets to an accuracy of ±1%. All equipment was tested with brass standards and UO_2 pellets. (auth)

22591 (NAMC-ASL-1050(Pt.IV)) DEVELOPMENT OF HIGH-TEMPERATURE STRAIN-GAGE BONDING MATERIALS CURABLE AT LOW TEMPERATURES. H. L. Rechter and S. W. Bradstreet (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Feb. 1960. Contract N156-37982. 73p. (NAVAIRMATCEN-ASL-1050(Pt.IV)).

Compositions were prepared which meet the objectives for the program for development of strain-gage bonding materials curable at low temperatures. A low-temperature formulation of tubular alumina in a potassium silicate sol with suspending agent will cure to a high degree below 200°F if presealed with silicone between air setting and heating, and is electrically serviceable to 800°F. A high-temperature composition, designated formulation B52, based on the monoaluminum dihydrogen phosphate-silica mixture, but with chromic anhydride and alumina hydrate additions, cures adequately at 400°F or below and is useful above the limiting service temperature of present strain-gage alloys, 1600°F. Both cement types display good resistance to thermal shock and repeated rapid cycling. They are also adequately strong for normal strain transmission purposes. The low-temperature cement is mechanically stronger at all temperatures. Differential thermal analyses verified curing temperatures and suggest the possibility of low-temperature vacuum curing of phosphoric acid compositions. (auth)

22592 (NAMC-ASL-1050(Pt.V)) DEVELOPMENT OF HIGH-TEMPERATURE STRAIN-GAGE BONDING MATERIALS CURABLE AT LOW TEMPERATURES. H. L. Rechter and Y. Harada (Illinois Inst. of Tech., Chicago. Armour Research Foundation). July 1961. Contract N156-39304. 49p.

Investigations were conducted to develop a high-temperature strain-gage cement which can be cured at low temperatures. Various compounds were incorporated into a basic formulation consisting of silica, alumina, chromic anhydride, monoaluminum dihydrogen phosphate, and Goulac suspending agent. The most satisfactory additive was yttrium nitrate hexahydrate which yields a composition, B144, with good curing at 350°F, excellent electrical behavior to 1600°F, and moderate strengths. Data on properties of cements containing other yttrium compounds, as well as zinc and magnesium compounds, are included. (auth)

22593 (NP-11795) LOW TEMPERATURE TENSILE PROPERTIES OF ZONE-REFINED NIOBIUM (COLUMBIUM). J. F. Wellings and R. Maddin (Pennsylvania. Univ., Philadelphia. School of Metallurgical Engineering). [1962]. 19p.

Specimens of electron beam zone-refined niobium were subjected to tensile tests in the temperature range from 373 to 4.2°K. Both polycrystalline and single crystalline specimens were tested at a constant strain rate of 3.3×10^{-4} seconds^{-1}. Specimens were either deformed to fracture or the temperature was changed during deformation to measure the reversible flow stress. The quantity of impurities remaining in the zone-refined material was ascertained by chemical analyses and the results were checked by resistivity measurements. It was found that a significant amount of zone-refining took place even at the relatively high rates of zone travel used (2mm/min.). Twinning was observed in all specimens tested at 4.2°K. No discontinuous yield points were observed in these tests indicating that this phenomenon is dependent upon impurity content. An increased impurity level resulted in a lowering of the yield and flow stresses without an appreciable change in the temperature dependence. This indicates that a lattice frictional stress is the possible mechanism responsible for the temperature dependence of the yield and flow stresses. (auth)

22594 (TID-15836) INVESTIGATION OF SPECIFIC VOLUMES OF LIQUID METALS AND ALLOYS. Report No. I. Frank A. Kanda and Douglas V. Keller (Syracuse Univ., N. Y.). Apr. 1, 1961. Contract AT(30-1)-2731. 36p.

Two recording high-temperature densitometers were de-

signed and built for investigation of density as a function of temperature in the liquid state. The density of the liquid is determined by the weight loss of a sinker suspended in the liquid media. From a plot of apparent weight change vs. temperature, density changes could be determined for any temperature range. Density determinations are reported for Al, Sn, and Bi. Relationships of densities and heat capacities were calculated. (M.C.G.)

22595 (TID-15971) NICKEL-RICH SOLID SOLUTIONS IN BINARY ALLOYS WITH TIN, GERMANIUM, AND SILICON. Technical Report No. 6. William Klement, Jr. (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). June 1962. Contracts AT(04-3)-221 and Nonr-220(30). 10p.

By rapidly cooling liquid alloys, single-phase nickel-rich solid solutions were obtained up to at least 12 at.% tin, at least 15 at.% silicon, and about 20 at.% germanium. The lattice parameters measured for the metastable structures as well as for some alloys within the equilibrium single-phase region suggest linear variations with solute content, with slopes (in units of 10^{-3} Å/at.% solute) of +8.5 for tin; $+1.9_4$ for germanium and -0.5_8 for silicon. (auth)

22596 (UCRL-6865) THE SELF-DIFFUSION OF IRON IN DELTA IRON. Richard J. Borg, David Y. F. Lai, and Oscar Krikorian (California. Univ., Livermore. Lawrence Radiation Lab.). Mar. 23, 1962. Contract W-7405-Eng-48. 16p.

The diffusion of Fe in δ Fe was measured using Fe^{59} as the tracer. The diffusion penetrations were determined both by sectioning and by the residual activity method. The results are summarized by the equation $D = 1.9 \exp[-57 \times 10^3/RT]$. The energy of activation is significantly lower than the value previously reported for the paramagnetic region of α Fe. It is possible that the diffusion coefficients of α Fe are affected by the short-range magnetic ordering. Alternatively, the decrease in activation energy may reflect a temperature dependence which is independent of the magnetic state and is a consequence of the extremely large range in temperature spanned by the measurements. (auth)

22597 (WADD-TR-60-924) THE THERMAL PROPERTIES OF THIRTEEN SOLID MATERIALS TO 5000°F FOR THEIR DESTRUCTION TEMPERATURES. David S. Neel, C. D. Pears, and Sabert Oglesby, Jr. (Southern Research Inst., Birmingham, Ala.). Nov. 1960. Contract AF33 (616)-6312. 214p.

The heat capacity, thermal expansion, and thermal conductivity were measured for thirteen different refractory materials, including ATJ graphite, tungsten, four nitrides, two borides, a silicate, and four carbides. The temperature range was from 500 to 5000°F. The heat capacity varied considerably with temperature and demonstrated marked inflections at specific temperature ranges. The thermal expansion parallel with the press direction was in the range of 3×10^{-6} in./in./°F and varied significantly with the prior thermal history of the specimen. At temperatures within about 1000°F of the melting or deterioration range, the motions of the materials generally increased considerably. The thermal conductivity perpendicular to the press direction was of the same value for materials of the same family, viz., the nitrides or carbides. The prior thermal history had a marked influence on the resulting values. Considerable information was obtained on the performance of 5000°F furnaces with graphite heaters, high temperature thermocouples, optical pyrometry, and the behavior of specimen materials in these 5000°F environments. All materials except a few failed at considerably below the handbook values for their melting or deterioration temperatures. (auth)

22598 (XDC-61-5-67) PROPERTIES OF LITHIUM HYDRIDE. III. SUMMARY OF GE-ANPD DATA. Frank H. Welch (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Apr. 19, 1961. Contracts AF 33(600)-38062 and AT(11-1)-171. 8p.

Lithium hydride property information as established by, or for, the Aircraft Nuclear Propulsion Department of General Electric is summarized. Data are presented on density (liquid), thermal conductivity, thermal expansion, viscosity, vapor pressure, dissociation pressure, compressive strength, compressive creep, modulus of rupture, modulus of elasticity, and modulus of rigidity. (auth)

22599 (AEC-tr-5095) METALLURGY—STATISTICAL STRUCTURES. Marc Salesse. Translated from Compt. rend., 253: 1331-3(1961). 8p.

The probability that structures affecting a number n of grains is present in a given direction of a polycrystalline body by an effect of statistical fluctuation was calculated. The results obtained were applied to uranium. (auth)

22600 (AEC-tr-5123) SUPERCONDUCTIVITY EXPERIMENTS IN THE NIOBIUM–TIN SYSTEM AND IN THE Nb_3Sn–Ta_3Sn MIXED CRYSTAL SYSTEM. H. G. Jansen. Translated from Z. Physik, 162: 275-89(1961). 21p.

In the intermetallic system Nb–Sn the compound Nb_3Sn with a superconducting temperature of 18°K was obtained by sintering techniques even with strong deviation from stoichiometric composition of the samples. A possible incorporation of the excess elements into the Nb_3Sn-lattice was manifested only by very minute changes of the critical temperature. A small atomic percentage of niobium-excess caused a maximum of the critical temperature. The critical temperature of mixed crystals of Nb_3Sn and Ta_3Sn changed almost linearly with composition. This system seemed to have some interest concerning theoretical aspects. (auth)

22601 (AEC-tr-5129) X-RAY STUDY OF THE PHASE COMPOSITION OF LEAD–CALCIUM ALLOYS. M. P. Smirnov and V. E. Rudnichenko. Translated from Analiz Rud Tsvetnykh Metal. i Produktov ikh Pererabotki, Sbornik Nauch. Trudov, No. 12, 150-62(1956). 16p.

X-ray phase analysis was used to establish that calcium in a lead–calcium plant alloy is present in the form of the intermetallic compound $CaPb_3$, which also participates in the removal of bismuth from lead. Studies of three synthetic alloys of the lead–calcium system containing 4.6, 20.8, and 25.6 wt % calcium show that $CaPb_3$ is the most stable of three compounds in this system. The possibility of carrying out an express, x-ray determination of the $CaPb_3$ content in plant alloy samples is pointed out. (auth)

22602 (AEC-tr-5192) THE DIFFUSION OF Kr^{85} IN ThO_2. Hansjoachim Matzke. Translated from Z. Naturforsch., 16a: 1255-7(1961). 9p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 16, abstract no. 12164.

22603 (HW-tr-37) DETERMINATION OF THE EQUILIBRIUM DIAGRAM BY SOLID STATE DIFFUSION. Y. Adda, M. Beyeler, A. Kirianenko, and F. Maurice. Translated by Liz Appleby (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.) from Mem. sci. rev. met., 58: 716-24(Sept. 1961). 22p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 16, abstract no. 3496.

22604 (HW-tr-38) EFFECT OF PRESSURE ON THE INTERMETALLIC COMPOUND FORMED BY DIFFUSION

BETWEEN URANIUM AND COPPER. Yves Adda, Michel Beyeler, and Alexis Kirianenko. Translated by Liz Appleby (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.) from Compt. rend., 250: 115-17(Jan. 4, 1960). 5p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract no. 7775.

22605 SLIDING CONTACT FRICTIONAL BEHAVIOR IN SODIUM ENVIRONMENTS. J. W. Kissel, W. A. Glaeser, and C. M. Allen (Battelle Memorial Inst., Columbus, Ohio). Am. Soc. Lubrication Engrs. Trans., 5: 39-44 (1962).

A study has been made of wear and friction phenomena associated with rubbing surfaces (primarily molybdenum) in sodium environments. Operating conditions include vacuum or argon environments and specimen temperatures from 80 to 1300°F. Sliding speeds were about one half inch per minute and contact stresses were about 100,000 psi. Sliding specimens consisted of a ball sliding on a flat rectangle. Wear and friction behavior were found to be influenced by surface films which were modified by the presence of liquid sodium. (auth)

22606 THE THEORY OF SWELLING OF POROUS MATERIALS. V. M. Agranovich and E. Ya. Mikhlin. Atomnaya Energ., 12: 385-91(May 1962). (In Russian)

Swelling of nuclear fuel materials is one of the most serious obstacles in the path of the utilization of nuclear energy. Previous studies of this phenomenon considered only cases in which the crystals have no other defects than lattice vacancies or foreign atoms; however, crystals of reactor fuels often exhibit fine cracks or inclusions which play an important role in the diffusion of the gaseous fission products. Other materials may contain a large number of fine pores as a result of the fabrication method used (such as powder metallurgy). In these cases swelling is caused by the filling of the pores with gaseous fission fragments. These fission gases diffuse slowly at low temperatures but an increase of the temperature accelerates strongly the diffusion process, causing ultimately an increase of the gas pressure within the pores beyond the elastic limit of the material; under these conditions the swelling rate increases rapidly. If the pore radii are low, the surface tension forces must also be taken into account. Formation of additional pores during the fission may be neglected. The calculations were based on 1 cm^3 of U-containing material which had about 10^{13} pores with an average diameter of 0.1 micron, amounting to a porosity of less than 1%. Irradiation of the specimen results in the formation of about 3×10^{12} fission fragments per cm^3 per sec. The time to the start of swelling was calculated to be 1.2 years at 327°C and 60 days at 727°C. (TTT)

22607 THE STRUCTURE OF δ-PLUTONIUM. J. A. S. Marples and J. A. Lee (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Atomnaya Energ., 12: 423-7(May 1962). (In Russian)

A close-packed face-centered cubic modification of δ-Pu was proposed recently by S. T. Konobeevskiĭ and N. T. Chebotarev (Atomnaya Energiya 10: 50(1961) No. 1). In additional to the original structure, the material should present additional x-ray lines according to this proposal. As the lines could not be clearly observed, it was assumed that the intensity of these lines amounts to only 1% of the neighboring lines of δ'(η) Pu. Recalculations were made and it is indicated that the proposed intensity of the superlattice lines varies within wide limits; however, an examination of δ-Pu specimens with a high-temperature Unicam camera did not reveal any of the lines, and a more sensitive diffractometric method also yielded negative results. Thus, the correctness of this superlattice structure appears to be doubtful. (TTT)

22608 HIGH TEMPERATURE THERMODYNAMIC PROPERTIES OF SOME OF THE RARE EARTHS. John Richard Berg (Iowa State Univ. of Science and Tech., Ames). Dissertation Abstr., 22: 2599(Feb. 1962).

The design and construction of a high temperature vacuum ice calorimeter is described. It was calibrated from 1100 to 1700°C with α-Al_2O_3, and the results were compared to other studies made on this material in the temperature range indicated. This instrument was used to determine the heat content of yttrium metal from 1100 to 1675°C. The heat contents of lanthanum, praseodymium, europium, ytterbium, and yttrium were studied on 0 to 1100°C using a conventional Bunsen ice calorimeter. The enthalpy of each metal was expressed as a function of temperature by fitting the data to empirical equations by a least-squares treatment; the form of these empirical equations varied for the temperature regions studied. Thus, for the range from room temperature to the high temperature crystalline transformation, a cubic expression would usually fit the data well; in the high temperature crystalline region and in the liquid, a linear expression could be used. From the empirical equations expressing the enthalpy data, the other thermodynamic functions were derived and evaluated at 50° intervals as well as at the transformation temperatures. The heats of crystalline transformation for lanthanum, praseodymium, europium, ytterbium, and yttrium were calculated to be 753, 760, 418, and 1189 calories per mole. The heats of fusion were calculated for lanthanum, praseodymium, europium, ytterbium, and yttrium to be 1482, 1652, 2204, 1830, and 2732 calories per mole, respectively. Quenching of the fcc modification of lanthanum in the room temperature hcp form was reduced by an annealing procedure that provided reproducible results. However, the exact amount of the higher energy form of lanthanum quenched in these studies is not known. Anomalies were found in the heat content curves of europium and ytterbium at 503 and 553°K. These small breaks were attributed to contributions to the heat capacity arising from 4f electronic transitions resulting from the presence of some trivalent ions in a predominantly divalent metal. The observed data confirmed density and other measurements that these two metals are primarily in the divalent state.

22609 PART I: CONDUCTIVITY OF THORIA POWDER IN CARBON DIOXIDE ATMOSPHERES. PART II: A PLATINUM CATALYST FOR THE COMBINATION OF HYDROGEN AND OXYGEN IN THORIA SLURRIES. Ralph Maurice Horton (Univ. of Utah, Salt Lake City). Dissertation Abstr., 22: 3846(May 1962).

Carbon dioxide was adsorbed on pellets pressed from thoria powder (22.8 m^2/gm) and the conductivity isotherms determined at temperatures between 250 and 550°C in a d-c electric field. The conductivity isotherms are explained by two parallel resistances, one consisting of bulk conduction controlled by the particle-to-particle contacts and the other resistance being explained by two alternate mechanisms: ionic conduction along the surface of the pores or thermionic emission across the pores. A theoretical interpretation of the results is given. A platinum catalyst was prepared by refluxing together an aqueous suspension of platinic acid and thorium hydroxide. A small amount of this catalyst was added to a thoria slurry in an autoclave. After the slurry was heated and while it was being agitated, oxygen and hydrogen were added to the autoclave and their

rate of combination followed by recording the pressure as a function of time. The reactions were usually first order with respect to pressure. Results indicated that the catalyst was adsorbed on the previously inert thoria, causing an increase in the rate. The activation energy for the process was 4.0 kcal/mole. The kinetics were found to be first order with respect to oxygen. These facts suggested that the slow step in the reaction was the diffusion of oxygen to the catalyst. The catalyst was found to maintain its activity even after 200 tests upon the same charge.

22610 VAPOR-SOLID EQUILIBRIA IN THE URANIUM OXIDE-OXYGEN SYSTEM. Carl Albert Alexander (Ohio State Univ., Columbus). Dissertation Abstr., 22: 3864 (May 1962).

Vapor pressures of UO_3 over non-stoichiometric uranium oxides were investigated by the transpiration method. A composition range from approximately UO_2 to U_3O_8 was investigated over a temperature range from 1410 to 1965°K. Oxygen pressures ranging from one atmosphere to 10^{-8} atmosphere were employed to stabilize the various phases and to supply the oxygen for oxidation of the condensed phase to the gaseous trioxide. A combination of the vapor pressure data with a standard free energy of formation value for the condensed oxide, over which vapor pressure determinations were made, permitted determination of the free energy of formation of the gaseous trioxide, as well as free energies at all compositions for which vapor pressure determinations were made. For this investigation, the free energy of formation of U_3O_8 was calculated from an assessment of the literature, valid in the range 1405 to 2000°K, and a value for $\frac{1}{3}U_3O_8(UO_{2.67})$ was found to be $\Delta G = -281{,}960 + 49.71T(K)$. On the basis of this value and the vapor pressure data, the free energy of formation for gaseous UO_3 was found to be $\Delta G = -202{,}080 + 20.79T$, and that for UO_2 to be $\Delta G = -257{,}530 + 41.47T$. In addition to determining free energies, the vapor pressures were used to extend the range over which dissociation pressures were determined. Use of dissociation pressures with standard free energies determined at the upper limit of oxygen solubility in the UO_2 phase, and the lower limit of oxygen solubility in the U_3O_8 phase, supplied the necessary additional information for the construction of a phase diagram depicting the dependence on oxygen pressure of the various phases of uranium oxide at temperatures to 2000°K.

22611 TARGET VAPORIZATION AND CRATERING ASSOCIATED WITH HYPERVELOCITY IMPACT. THE OXIDATION KINETICS OF ZIRCONIUM CARBIDE. Robert Watkins Bartlett (Univ. of Utah, Salt Lake City). Dissertation Abstr., 22: 3973-4(May 1962).

A study of the behavior of metals under very high velocity impact, which emphasizes vaporization and cratering, was made. Jets from shaped charged explosives and discrete particles accelerated by high explosives were used as penetrators. Studies were made at velocities up to 8.5 km/sec using a variety of target and penetrator materials. The impact velocities were sufficiently high to produce target vaporization in many metals and the vapors were luminous for short periods of time permitting photography with a microsecond framing camera. The vapors exhibited a high degree of ionization as evidenced by electrical conductivity. The ionization decayed faster in air and various inert gases than in vacuum. Small quantities of the condensed vapors were collected and analyzed to determine the ratio of penetrator metal to target metal in the vapor condensate as a function of impact velocity. Mixtures of metal oxides were indicated but the x-ray-diffraction patterns did not permit conclusive identification of specific compounds. Some condensation of reduced metal also was observed; aluminum, iron and zinc; and a substitutional solid solution alloy, alpha brass, was produced by the simultaneous condensation of copper and zinc vapors originating from different targets impacted in tandem. A mechanism of cratering in metal targets impacted by shaped charge jets in which the crater diameter was expressed as a function of striking velocity, jet diameter, densities of target and jet, and the yield strength of the target was compared with measured crater diameters in several different metals struck by iron, copper and aluminum jets at various velocities. The same mechanism was expanded to account for the dynamics of crater formation, i.e., the radial rate of expansion of the crater as a function of forward penetration of the crater. The parabolic curve which was derived was compared with the experimental results for steel jets penetrating several transparent substances of different densities. Microsecond framing camera techniques were used to obtain experimental data. The rate of oxidation of zirconium carbide was measured in oxygen pressures from 50 microns to 6.8 atmospheres using a thermogravimetric apparatus consisting of a helical quartz spring and a cathetometer. Sized loose powders were placed in a platinum crucible and suspended from the spring into a resistance furnace. A geometric correction was used to normalize the surface area of the particles as they oxidized. The rate became appreciable above 450°C and the oxidation products were primarily cubic zirconia although minor amounts of monoclinic zirconia were occasionally encountered. The oxidation consisted of adsorption of O_2 on the surface with surface saturation at a pressure of about 4 mm. Oxidation followed a linear time plot, i.e., the rate remained constant for any fixed temperature. As the oxygen pressure increased atomic oxygen began to diffuse into the ZrC lattice, partially replacing carbon. This parabolic diffusion process occurred concurrently with the linear oxidation step. After the lattice became saturated, which occurred rapidly at pressures above 0.1 atmosphere, the linear reaction continued alone except that the reaction

$$Zr(C_xO_y) + nO_2 \rightarrow ZrO_2 + \begin{bmatrix} CO \\ CO_2 \end{bmatrix}$$

with a slightly smaller weight gain occurred. An activation enthalpy of 45.7 kcal/mole was determined for the linear oxidation process. An enthalpy of −12.4 kcal/mole was determined for the adsorption of O_2 on surface sites where the linear reaction took place. An activation enthalpy of 53.2 kcal/mole was determined for the diffusion process. High oxygen pressures had a retarding effect on the linear rate evidently by reducing the number of active sites or reactants, such as vacancies, since the activation enthalpy is not changed. High pressures had no observable effect on the diffusion rate. Water vapor did not oxidize zirconium carbide at the temperatures investigated but in the presence of oxygen the linear rate was increased in direct proportion to the water vapor pressure. Water did not change the activation enthalpy and therefore did not change the mechanism. Evidently the number of surface active sites were increased by the water. Various models designed to account for the experimental results are discussed.

22612 PHYSICAL PROPERTIES OF ZIRCONIUM NITRIDE IN THE HOMOGENEITY REGION. G. V. Samsonov and T. S. Verkhoglyadova (Inst. of Metal Ceramics and Special Alloys, Academy of Sciences, Ukrainian SSR). Dopovidi Akad. Nauk Ukr. R.S.R., No. 1, 48-50(1962). (In Ukrainian)

The x-ray method was used to determine the homogeneity region of zirconium nitride as 40 to 50 at.% (9.5 to 13.3%

by weight) of nitrogen. It is also shown that part of the ionic bond in the zirconium nitride lattice increases with a decrease in the nitrogen content in this region, this increase being higher than in the homogeneity region of titanium nitride due to the smaller degree of unfilling of the electron d-shell of the zirconium atom in comparison with that of the titanium atom. (auth)

22613 ON THE THERMODYNAMIC PROPERTIES OF ZIRCONIUM OXIDES, ZIRCON, ALUMINUM AND MAGNESIUM TITANATES. A. S. Berezhnoi (Ukrainian Inst. of Refractory Materials). Dopovidi Akad. Nauk Ukr. R.S.R., No. 1, 65-8(1962). (In Ukrainian)

Calculation methods were used to determine the heats of formation from oxides, ΔH°_{298}, for $ZrSiO_4$, Al_2TiO_5, $MgTiO_3$, and Mg_2TiO_4. They were respectively −4.8, +2.7, −5.6, −2.4, and −4.4 kcal/mol. On the basis of the published experimental data a P−T diagram for ZrO_2 was constructed and analyzed. The values of the isobaric thermodynamic potential $\Delta Z(T)$ for the formation of these compounds were computed, and their stability at high temperatures and pressures analyzed. At high pressures the most stable magnesium titanate was geikielite, $MgTiO_3$, while $MgTi_2O_5$ was least stable. Magnesium titanate, on forming a solid solution in Al_2TiO_5, increased the stability of the latter. (auth)

22614 ON THE EXISTENCE BOUNDARY OF THE σ-PHASE IN THE TANTALUM−VANADIUM SYSTEM. V. N. Eremenko, L. A. Tretyachenko, and Z. P. Golubenko (Inst. of Metal Ceramics and Special Alloys, Academy of Sciences, Ukrainian SSR). Dopovidi Akad. Nauk Ukr. R.S.R., No. 2, 194-5(1962). (In Ukrainian)

A σ-phase was formed at 1420°C from a solid solution of tantalum and vanadium containing ~33 at.% of Ta. The range of existence of the σ-phase extended on lowering the temperature, and at 1000°C the σ-phase existed in alloys containing from 5 to 65 at.% of Ta. The homogeneity region of the σ-phase at 1000°C was between 30 and 43 at.% of Ta. The results of the investigation are presented on the state diagram of the system. In an alloy with 32 at.% of Ta the σ-phase has crystal lattice parameters a = 6.15, C = 8.85 kX. (auth)

22615 COMPOUNDS OF OSMIUM AND RHENIUM WITH THE ORDERED PEROVSKITE STRUCTURE. Arthur W. Sleight, John Longo, and Roland Ward (Univ. of Connecticut, Storrs). Inorg. Chem., 1: 245-50(May 1962).

A description is given of the preparation and characterization of a number of compounds of the type $A_2BB^{I}O_6$ where A = Ca, Sr, Ba; B^{I} = Re or Os; and B represents a variety of univalent, divalent, and trivalent cations. Evidence was obtained for the existence of heptavalent osmium in the compound Ba_2LiOsO_6. The structure of many of these compounds was of the ordered perovskite type, but the hexagonal barium titanate structure was adopted in the osmium compounds when A is barium and B is a transition metal cation having d electrons. This structure also was found with the compounds $Ba_3Cr_2ReO_9$ and $Ba_3Fe_2ReO_9$. Preliminary measurements of the magnetic properties of some of the compounds are reported. (auth)

22616 METAL CHEMISTRY. 3. METAL CHEMISTRY OF Nb. I. I. Kornilov and R. S. Polyakova (Inst. of Metallurgy, Academy of Sciences, USSR). Izvest. Akad. Nauk S.S.S.R., Otdel. Khim. Nauk, No. 4, 565-73(Apr. 1962). (In Russian)

An analysis of Nb metallo-chemical properties indicates four different types of combinations: continuous solid solutions, limited solution, ion combinations and noninteracting elements. Constitution diagrams of the more important alloys are constructed and analyzed. Diagrams of Nb−Zr, Nb−U, Nb−Al, Nb−B, and Nb−C are included. (R.V.J.)

22617 STRUCTURE AND PROPERTIES OF W−C−Co−Mo ALLOYS. V. F. Funke, T. A. Novikova, and V. I. Tumanov (All-Union Scientific Research Inst. of Metals, USSR). Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk Met. i Toplivo, No. 2, 113-18(Mar.-Apr. 1962). (In Russian)

The effect of Mo and C on the phase composition of W−C−Co−Mo systems and the chemical composition of various phases were studied. The hardness of some W−C−Co−Mo systems exceeds the hardness of W−C−Co at room and elevated temperatures. (R.V.J.)

22618 PHASE DIAGRAM AND CERTAIN PROPERTIES OF Nb−Mo−W ALLOYS. E. M. Savitskii, V. V. Baron, and K. N. Ivanova. Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk Met. i Toplivo, No. 2, 119-25(Mar.-Apr. 1962). (In Russian)

A phase diagram was constructed for Nb−Mo−W alloy, and various properties were studied at various temperatures: the hardness at 20 and 1000°C, oxidation at 1200°C, and ductility at room temperature. An unlimited solubility of the components was observed in both liquid and solid states. Solidus isotherms showed that with reduced W content the melting temperature is reduced from 3200 to 2400°C. Alloys with 70 to 90% Nb exhibited the lowest tendency to softening at 1000°C. (R.V.J.)

22619 THERMAL DIFFUSIVITY OF Nd AND Ce IN SOLID MAGNESIUM. L. L. Rokhlin. Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk Met. i Toplivo, No. 2, 126-30 (Mar.-Apr. 1962). (In Russian)

The solubility of Nd and Ce in Mg was studied by measuring their specific electric resistivity as functions of annealing and composition. The results for various temperatures are tabulated. The data show that the maximum solubility of Nd in Mg in atomic % exceeds the maximum Ce by a factor of 5, confirming a postulation that the good mechanical properties of Nd−Mg result from a high Nd solubility in Mg. (R.V.J.)

22620 ELECTROCONDUCTIVITY OF OXIDE FILMS ON TiB_2 SPECIMENS. Yu. D. Kobtsev (Kiev Polytechnic Inst.). Izvest Vysshikh Ucheb. Zavedenii, Fiz., No. 2, 21-4(1962). (In Russian)

The relation between TiB_2 conductivity and oxidation was studied. The electric conductivity and non-linear volt-amp characteristics of specimens are analyzed as a means of utilizing oxidation films for non-linear resistance. (tr-auth)

22621 CONDUCTIVITY OF PREPARED GRAPHITE. S. V. Shulepov and M. I. Pashnin (Cherlyabinsk Pedagogical Inst., USSR). Izvest. Vysshikh Ucheb. Zavedenii, Fiz., No. 2, 34-9(1962). (In Russian)

The Hall effect, Nernst-Ettinhauser effect, and electric resistance of prepared graphite were studied above 2000°C. Data on graphite conductivity, concentration of current carriers, and carrier mobility are discussed. (tr-auth)

22622 DIFFUSION EFFECTS ON THE THIN FILM STRUCTURE OF LIQUID Al−Sn ALLOYS. A. G. Buntar (Inst. of Mining and Metallurgy, USSR). Izvest. Vysshikh Ucheb. Zavedenii, Fiz., No. 2, 83-6(1962). (In Russian)

An analysis of diffusion effects on a thin ($\sim 3 \times 10^{-4}$ cm) film structure of liquid Al−Sn alloys showed that surface processes do not affect significant changes in the number of adjoining atoms. (tr-auth)

22623 DIFFUSION OF Al^{26} AND Mn^{54} IN ALUMINUM. T. S. Lundy and J. F. Murdock (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 33: 1671-3(May 1962).

Diffusion coefficients of Al^{26} and Mn^{54} in aluminum were determined between 450 and 650°C. Low specific activities of the isotopes necessitated use of a thick layer technique. The exact solution to Fick's second law for the appropriate boundary conditions was used in treating the data. The temperature dependence of the diffusion coefficients is found. (auth)

22624 MAGNETIC MOMENTS OF INTERMETALLIC COMPOUNDS OF TRANSITION AND RARE-EARTH ELEMENTS. E. A. Nesbitt, H. J. Williams, J. H. Wernick, and R. C. Sherwood (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 33: 1674-8(May 1962).

The effect of adding the rare-earth elements to cobalt, iron, and nickel was investigated. Antiferromagnetic coupling was found to exist in the cobalt and iron rare-earth compounds. The moment per formula unit of the compound Co_5Y increased when Sm, Pr, and Nd were substituted for yttrium and decreased when Tm, Gd, Tb, Er, Dy, and Ho were substituted. This result was explained on the basis that although the spin moments of cobalt and rare earths were coupled antiferromagnetically in these compounds, the orbital moments added to the cobalt moment in the compounds containing Sm, Pr, and Nd, but they subtracted from the cobalt moment in the compounds containing Tm, Tb, Er, Dy, and Ho. For the iron compounds investigated, the moment of the compound Fe_4Y was found only to decrease when Tm, Er, Ho, and Dy were substituted for yttrium. The nickel compounds behaved entirely differently from the cobalt and iron compounds. Very little or no antiferromagnetic coupling was observed in these compounds. (auth)

22625 ANISOTROPY OF SELF-DIFFUSION IN ALPHA URANIUM. S. J. Rothman, J. J. Hines, J. Gray, Jr., and A. L. Harkness (Argonne National Lab., Ill.). J. Appl. Phys., 33: 2113-16(June 1962). (ANL-FGF-314)

Self-diffusion along the three principal crystallographic directions of alpha uranium was measured on mosaic-structured single crystals by the tracer-sectioning method. The diffusion coefficients at 625.5°C are $D_{[100]} = D_{[001]} = 1.95 \times 10^{-13}$ cm²/sec and $D_{[010]} \leq 10^{-14}$ cm²/sec. The mosaic structure apparently has not affected the diffusion significantly. (auth)

22626 DEFORMATION OF URANIUM UNDER CONSTANT LOAD AND CYCLIC TEMPERATURE. K. R. Merckx and K. R. Wheeler (Hanford Atomic Products Operation, Richland, Wash.). J. Basic Eng., 83: 294-6 (June 1962).

Tests were conducted on uranium under constant load and cyclic temperature. The work was different from earlier tests in that longer periods were used for the temperature cycle. The results obtained from four series of tests with the load varying from 500 to 2000 psi and the temperature cycled between 150 and 450°C are shown in graph form. The strains were orders of magnitude larger than would have occurred at maximum temperature. (M.C.G.)

22627 ELECTRICAL CONDUCTIVITY OF NON-STOICHIOMETRIC α-Nb_2O_5. E. H. Greener and W. M. Hirthe (Marquette Univ., Milwaukee). J. Electrochem. Soc., 109: 600-3(July 1962).

The electrical conductivity of reduced $\alpha - Nb_2O_5$ was measured after prior reduction in 10^{-6} atm of air from 350 to 1150°K for both single crystals and sintered specimens. The conductivity of single crystals was found to be exponentially dependent on temperature with an activation energy of 0.9 ev in the range from 1150 to 650°K and 0.2 ev in the range from 650 to 350°K. The electrical conductivity of sintered specimens was also found to be exponentially dependent on temperature, but only a single activation energy was obtained over the entire temperature range. This activation energy was dependent on defect concentration and varied from 1.0 ev for the smallest degree of reduction to almost zero at the highest degree of reduction where the behavior was essentially that of a degenerate semiconductor. An explanation based on overlapping orbitals of trapped electrons is offered to explain both the dependence of activation energy on defect concentration and the absence of a low-temperature activation energy in sintered material. Finally, two mechanisms are discussed to explain the observed conductivity of reduced $\alpha - Nb_2O_5$. Comparison of conductivity data and thermoluminescence data tends to favor a model in which two trapped electrons are excited from an oxygen vacancy to the "d" band of the niobium cations. (auth)

22628 PARTITION OF SOLUTES BETWEEN LIQUID METALS. I. THE ALUMINUM–CADMIUM SYSTEM. Fred A. Cafasso, Harold M. Feder, Irving Johnson (Argonne National Lab., Ill.). J. Phys. Chem., 66: 1028-30(June 1962).

The mutual solubilities of molten aluminum and cadmium were measured and the partition of Pd, La, Ce, Pr, and U between these solvents was examined. The partition coefficients (Al/Cd) of the lanthanons decreased in the order Ce > Pr > La. The partition coefficient of uranium and its activity coefficient in cadmium were used to estimate the activity coefficient of uranium in aluminum solution. An approximate equation was derived which connects the partition coefficient of a solute and its activity coefficient in each of two solvents which are partially miscible. (auth)

22629 THE DENSITY OF LIQUID COPPER FROM ITS MELTING POINT (1356°K.) TO 2500°K. AND AN ESTIMATE OF ITS CRITICAL CONSTANTS. J. A. Cahill and A. D. Kirshenbaum (Temple Univ., Philadelphia). J. Phys. Chem., 66: 1080-2(June 1962).

The density of liquid copper was determined in an argon atmosphere by the immersed sinker method from 1356 to 2500°K. Zirconium dioxide coated molybdenum sinkers with aluminum oxide and zirconium oxide crucibles were employed below 2100°K, while graphite sinkers and crucibles were used to 2500°K. The density, with respect to temperature, is best expressed by the equation $D\ g/cm^3 = 9.077 - 8.006 \times 10^{-4}T$°K. The liquid density at the melting point (1356°K) was 7.992 g/cm³ and 6.792 g/cm³ at the normal boiling point (2855°K). The molar volumes and thermal coefficients of expansion of liquid copper were calculated. Copper upon melting was found to expand 4.51% of its solid volume. The critical constants of copper were estimated to be: $T_{crit.} = 8900 \pm 900$°K; $D_{crit.} = 1.04 \pm 0.2$ g/cm³; $V_{Mcrit.} = 61 \pm 10$ cm³/mole. (auth)

22630 THE ELECTRICAL CONDUCTIVITY OF SOLUTIONS OF METALS IN THEIR MOLTEN HALIDES. V. PRASEODYMIUM–PRASEODYMIUM TRICHLORIDE. A. S. Dworkin, H. R. Bronstein, and M. A. Bredig (Oak Ridge National Lab., Tenn.). J. Phys. Chem., 66: 1201-2(June 1962).

The electrical conductivity of $Pr - PrCl_3$ systems was determined. The increase in specific conductivity with metal concentration was not so fast as that for La and Ce, but it was faster than that for Nd. The upward curvature of the specific conductance vs. concentration curve was attrib-

uted to a gradual overlap of the orbitals of conduction electrons. (M.C.G.)

22631 SUPERCONDUCTIVITY IN THE $CuAl_2$ (C16) CRYSTAL CLASS. M. F. Gendron and R. E. Jones (International Business Machines Corp., Yorktown Heights, N. Y.). Phys. and Chem. Solids, 23: 405-6(Apr. 1962). (In English)

Several superconducting compounds are found in the $CuAl_2$ (C16) crystal class, indicating that this structure is among those favorable to the occurrence of superconductivity. The compounds include $AuPb_2$ (T_c = 4.42°K), $PdPb_2$ (T_c = 2.95°K), $RhPb_2$ (T_c = 2.66°K) and $AgIn_2$ (T_c = 2.30 to 2.46°K). In addition, two compounds related to the C16 class are found to be superconducting, viz. $AuSn_4$ (T_c = 2.38°K) and $PtPb_4$ (T_c = 2.80°K). (auth)

22632 CONCLUSIONS FROM SUPERCONDUCTING MOLYBDENUM TECHNETIUM ALLOYS. B. T. Matthias (Bell Telephone Labs., Inc., Murray Hill, N. J.). Revs. Modern Phys., 33: 499-500(Oct. 1961).

Experiments discouraging substantial increase in transition temperatures are reported. Measurements were performed on pure elements and on intermetallic phases and compounds, and superconductivity data in the Mo–Tc system are presented. Ranging from pure metallic alloys having wide homogeneity ranges to intermetallic compounds having virtually no homogeneity range, from interstitial compounds to solid solutions, the maximum transition temperatures always seem to be at 16 to 18°K. (L.N.N.)

22633 NEUTRON DIFFRACTION OF MAGNETIC MATERIALS. G. S. Zhdanov and R. P. Ozerov. Uspekhi Fiz. Nauk, 76: 239-82(Feb. 1962). (In Russian)

A review of neutron diffraction of magnetic materials is presented. The topics covered include: (1) A discussion of slow neutron scattering including nuclear and magnetic effects, with examples and typical experimental arrangements. (2) The determination of magnetic moments. In this section various models for Fe_4N and Mn_4N are discussed, as are magnetic moments of $FeNi_3$, Fe_3Al, and magnetic moments of transition metals and magnetic moments in the paramagnetic region. (3) Magnetic structure of transition metals. In this section are presented results concerning the antiferromagnetic structure of these metals, principally chromium; a description of magnetic symmetry; and the new class of spiral structures. (4) Magnetic structure of some compounds: the perovskite group of iron compounds; the perovskite group of rare earth metals; the antiferromagnetism of transition metal carbonates; and trifluorides of transition metals. The breakdown of Hund's rule is discussed, as is the magnetic anisotropy of some manganese compounds. (5) Magnetic critical and small angle scattering of neutrons. A qualitative discussion of Van Hove's theory is given. Results of small-angle scattering from iron at various temperatures are presented. Distant and close magnetic interactions are briefly noted, as is the dynamics of spin correlations. (6) Scattering of neutrons by spin waves. This section includes a brief discussion of magnons; the dispersion law of spin waves; and experimental results of scattering by spin waves. (7) Magnetic scattering of conduction electrons; principally the electrical resistance of disordered magnetic structures. Spin interactions are mentioned in connection with superconductivity. (116 references) (TTT)

22634 STRUCTURE AND PROPERTIES OF SILVER–CADMIUM–ZINC ALLOYS. II. Guenter Petzow (Max-Planck-Institut für Metallforschung, Stuttgart) and Ewald Wagner. Z. Metallk., 53: 189-95(Mar. 1962). (In German)

Previous data on the ternary system Ag–Cd–Zn were extended by a combination of metallographic, thermal analysis, temperature-temperature difference, and x-ray measurements. Special regard was given to the determination of the melting equilibrium and the four-phase transformation. In addition to this, seven vertical sections are presented which give a conception of the shape of the phase region in dependence on the temperature and concentration. Three four-phase equilibria at 440, 285, and 270°C were determined in this ternary system. Data are given which describe some properties of Ag–Cd–Zn alloys, especially the deformability, staining, hardness, and tensile strength after butt welding. (auth)

22635 MAGNETIC MEASUREMENTS IN THE BISMUTH–COBALT SYSTEM. Ralf Damm, Erich Scheil, and Ernst Wachtel (Max-Planck-Institut für Metallforschung, Stuttgart). Z. Metallk., 53: 196-203(Mar. 1962). (In German)

The solubility curve of solid Co in liquid Bi was determined in the range between 0.05 and 0.5 at. % Co. The eutectic point was found to lie at 0.04 at. % Co and 271.2°C instead of 10 at. %. The progress of the precipitation process of solid Co in Bi–Co melts was investigated by susceptibility measurements. The supercooling of the precipitation after a considerable superheating of the melt is caused by the dissolution of an inoculated substance that is stable below 750°C. The supercooling is not due to the melting of Co particles remaining in the melt. The size of the suspended Co particles in the two-phase region of the melt was determined by measurements of the field strength as a function of the magnetization intensity. The medium size of the particles does not change between the solidus, and the liquidus temperature; their number decreases with increasing solubility. The particles contain about 2×10^4 atoms. The particle size forms therefore a limit between ferromagnetism and superparamagnetism. (auth)

22636 DEVELOPMENT OF A SEPARATION-VEHICLE CORROSION-RESISTANT NICKEL–CHROMIUM–MOLYBDENUM ALLOY. Immanuel Class (Badische Anilin- und Soda-Fabrik A. G., Ludwigshafen, Ger.). Hubert Graefen, and Erich Scheil. Z. Metallk., 53: 283-93(May 1962). (In German)

Hastelloy C shows a strong tendency for σ-phase precipitation on grainboundaries which is due to a large supersaturation. A change of the composition was made to obtain a certain precipitation inertia. For the purpose of finding the most favorable composition three isothermal sections were made in the Ni-corner of the ternary system Ni–Cr–Mo. It was found that the precipitation rate of the σ-phase in the pure ternary alloy is much lower than in the technical alloy. The influence of the remaining alloying elements was thereupon analyzed and it was detected that by the addition of silicon, both the precipitation rate and the σ-phase region are considerably increased especially to higher temperatures. Among the elements tried for the deoxidation of the alloy, Mg in the form of a Mg–Ni pre-alloy was found suitable instead of silicon. On the ground of experimental results new silicon-free alloys with different composition were melted. There are superior to technical alloys. Their resistance to corrosion and their toughness is much better. The heat treatment is not complicated and they are not so sensitive to welding. (auth)

22637 THE CONSTITUTION OF SILVER–ALUMINUM–MANGANESE ALLOYS IN THE PARTIAL REGION OF SILVER–MANGANESE–AlMn. Werner Koester and

Werner Horn (Max-Planck-Institut fur Metallforschung, Stuttgart). Z. Metallk., 53: 294-8(May 1962). (In German)

The constitution of Ag–Al–Mn alloys, as the partial system Ag–Mn–AlMn, was investigated by a combination of microscopical, x-ray, and dilatometric methods. (auth)

22638 CONCERNING THE CAUSES OF THE FERROMAGNETISM OF THE SILVER–MANGANESE–ALUMINUM ALLOYS. Werner Koester and N. K. Anantha Swamy (Max-Planck-Institut fur Metallforschung, Stuttgart). Z. Metallk., 53: 299-301(May 1962). (In German)

The supersaturated face-centered-cubic (F.C.C.) silver solid solution in Ag–Al–Mn alloys precipitates below 450°C a meta-stable, ferromagnetic f.c.c. crystal (a = 3.72Å) which is defined as the γ–Mn–Al solid solution. Prolonged annealing or a temperature increase causes the γ–Mn solid solution to transform into the equilibrium phase, β–Mn–Al solid solution. The ferromagnetism of the "Silmanal" alloy is based on the precipitation of a meta-stable ferromagnetic phase. (auth)

22639 CRYSTAL STRUCTURE AND COMPOSITION OF OXIDE LAYERS ON IRON–CHROMIUM–ALUMINUM ALLOYS IN DEPENDENCE OF THE OXIDE LAYER THICKNESS. Irmtraud Pfeiffer (Laboratorium der Vacuumschmelze A. G., Hanau, Ger.). Z. Metallk., 53: 309-12 (May 1962). (In German)

Oxide scales of different thickness formed on FeCrAl wires by air oxidation between 800 and 1200°C were identified by electron- and x-ray diffraction. The first thin oxide films of about 300 Å thickness show, besides aluminium oxide, a considerable content of the spinel $FeAl_2O_4$. Scales of a thickness of some 1000Å or some μ mainly consist of pure Al oxide. In thin films formed between 800 and 1000°C the Al oxide is found to be γ–Al_2O_3 whereas thicker scales formed on same conditions consist of α–Al_2O_3. The existence of Al_2O_3 in different modifications is discussed. The results were compared with those of the above-mentioned authors. (auth)

22640 DATA ON THE TEMPERATURE DEPENDENCE OF THE COMPRESSION MODULUS OF PURE METALS. Karl-Heinz Schramm (Battelle-Institut, Frankfurt am Main). Z. Metallk., 53: 316-20(May 1962). (In German)

With the help of the thermal expansion coefficient the temperature dependence of the compression modulus of 33 pure metals was calculated. (tr-auth)

22641 METAL SPHERULE IN THE SYSTEM NICKEL–ALUMINUM–BORON. Joachim-Dietrich Schoebel and Hans H. Stadelmaier (North Carolina State Coll., Raleigh). Z. Metallk., 53: 326-8(May 1962). (In German)

An x-ray and metallographic investigation clarified the nickel-rich side of the binary system of nickel–aluminium. It confirmed that the eutectic reaction at 25 at. % Al is liquid $\rightarrow \alpha + \alpha'$. The binary eutectic ($\alpha + \alpha'$) takes on a spherulitic habit in the ternary system nickel–aluminium–boron. The existence of a nucleus of primary α is a prerequisite for the formation of the nodules. (auth)

22642 ELECTRIC RESISTANCE OF CERIUM AT LOW TEMPERATURES AND HIGH PRESSURES. E. S. Itskevich (Inst. of High-Pressure Physics, Academy of Sciences, U.S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1173-82 (May 1962). (In Russian)

The temperature dependence of the resistance of two cerium samples is measured between 10 and 300°K at normal pressure and at pressures up to 10,000 kg/cm^2. The measurements are carried out in a bomb in which the pressure is fixed by a screw. The magnitude and character of the resistance variation due to pressure and temperature transitions are shown to be the same. The pressure transition is not complete up to 10,000 kg/cm^2. The resistance of fcc'-cerium linearly increased with temperature from 50 to 300°K, the coefficient being $\rho_0^{-1}\Delta\rho/\Delta T = 3.12 \times 10^{-3}$ degree^{-1}. Between 10 and 40°K the temperature dependent part of the resistance is proportional to T^2. The resistance anomaly at 12.5°K found by other authors is not confirmed. It is suggested that the phase diagram branches of cerium below room temperature are parallel. An approximate value is derived for the temperature at which the abrupt change of ρ at the transition fcc $\rightarrow$ fcc' vanishes. (auth)

22643 THE RESISTANCE OF METAL MATERIALS TO ALTERNATING THERMAL STRESSES. A. Matting and V. Deutsch (Technische Hochschule Hanover). IAEA Preprint CN-13/5. 43p. (In English)

To be published in the Proceedings of the IAEA Conference on the Corrosion of Reactor Materials held in Salzburg, 4-9 June 1962.

Test apparatuses for determining the resistance of a material to alternating thermal stresses are described, and a model of the stresses is presented. It is shown that external observations or surface roughness measurements are not sufficient for studies of alternating thermal stresses, and non-destructive testing methods are discussed. Studies were made on the alternating thermal stress resistance of steels, and ways of improving the resistance were tested. Comparisons are made between alternating thermal stress resistance and other mechanical properties. A test stand is proposed for the rapid determination of alternating thermal stress resistance. (D.L.C.)

22644 THE INFLUENCE OF VARIOUS GASEOUS ENVIRONMENTS ON THE CREEP-RUPTURE PROPERTIES OF NUCLEAR MATERIALS SELECTED FOR HIGH-TEMPERATURE SERVICE. H. E. McCoy, Jr. (Oak Ridge National Lab., Tenn.). IAEA Preprint CN-13/22. 56p. (In English)

To be published in the Proceedings of the IAEA Conference on the Corrosion of Reactor Materials held in Salzburg, 4-9 June 1962.

In order to increase the operating temperature of gas-cooled reactors, one must consider many problems in the selection of structural materials and fuel element claddings. Among these are the interactions of active metals and gases together with the attendant changes in the creep properties, ductility, and rupture life. Various types of gas-metal interactions are discussed and their effects upon the service performance of metals are illustrated by experimental data. Pure gases which are potentially suitable for reactor coolants as well as those gases which may be present as impurities were studied. These include Ar, H_2, CO_2, CO, N_2, O_2, and air. Three basic classes of materials were evaluated: austenitic stainless steels, nickel-base alloys, and refractory metals. The results of tests of austenitic stainless steels over the temperature range of 700 to 900°C show that their properties are essentially equivalent in argon and in hydrogen environments. Various degrees of strengthening were observed in air, N_2, O_2, CO, and CO_2 environments. The results of a series of tests at 815°C in environments containing various partial pressures of oxygen in argon are presented which show that the properties of stainless steels can be markedly altered by the presence of a few parts per million of oxygen. The responsible mechanisms are postulated in each case. The work on nickel-base alloys was centered around Inconel and "A" nickel. However, supplementary tests were conducted on high-purity nickel and on several

laboratory melts to evaluate the influence of composition. In contrast with the austenitic stainless steels, these tests show that the creep properties of nickel-base alloys are inferior in hydrogen as compared with those observed in argon. This effect is manifested through an increase in the secondary creep rate and a decrease in the time to rupture. No significant changes in ductility were observed. Environments which are carburizing, oxidizing, or nitriding are shown to result in an increase in the creep strength of nickel-base alloys. Proposed mechanisms for the observed creep behavior are presented. The refractory metals, exemplified by columbium, were found to be strengthened at room temperature by the addition of controlled amounts of oxygen, nitrogen, hydrogen, or carbon. However, serious embrittlement resulted if excessive quantities were added. Allowable concentration limits for each of the above interstitials are presented. The increase in high-temperature creep strength of columbium as a result of the addition of nitrogen and oxygen is demonstrated. (auth)

22645 ANNEALING KINETICS OF QUENCHED-IN RESISTANCE OF ALPHA-URANIUM. B. D. Sharma and K. Tangri (Atomic Energy Establishment, Trombay, India). IAEA Preprint SM-25/43. 15p. (In English)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials held in Venice, Italy, 7-11 May 1962.

Results of investigations on the "quenched-in" residual resistivity of high-purity alpha-uranium are reported. Experiments were carried out on thin strips of alpha-uranium quenched from within the alpha-range with a high cooling rate. The decay of resistance at liquid nitrogen and room temperatures were measured. From the calculations of activation energies for these recovery processes, it is seen that recovery at room temperature is primarily due to annealing of lattice vacancies and vacancy-impurity complexes. Low temperature recovery, however, could not be explained by current theories of the quenched-in defects. This behavior can possibly be attributed to the migration of some of the impurities which are likely to be pinned into interstitial holes during quenching. (auth)

22646 INTERNAL FRICTION IN URANIUM. V. E. Ivanov and B. C. Shapoval. IAEA Preprint SM-24/84. 9p. (In Russian)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials held in Venice, Italy, 7-11 May 1962.

A new method is given for determining internal friction in metals. Unlike existing procedures, the new method involves measurements of forced oscillations, when variation in the internal friction is indicated by change in the amplitude of the resonance oscillations. (Measurements are made when the amplitude is low; i.e., when internal friction is independent of amplitude.) With this method, it is possible to measure the internal friction over a wide range of rates of heating and cooling of the sample. The curves showing the temperature-dependent amplitude changes can be recorded automatically, without the intervention of the experimenter. The internal friction Q^{-1} in uranium was studied in the temperature range 20 to 500°C, and a maximum value for Q^{-1} was found at 250°C. The height of this maximum depends on the rate of temperature variation, a finding which corresponds to the observation made when carrying out measurements on zirconium regarding the existence of a "hydride" maximum. Additional experiments on the annealing of uranium in a hydrogen atmosphere confirm the hypothesis that the existence of a maximum is linked with the formation of uranium hydride, although it is not out of the question that the appearance of a maximum may also be due, in this case, to the influence of stresses within the sample. The role of stresses needs further investigation. When the material cools from 500°C to ambient temperature, internal friction does not return to its initial level. It is found that the internal friction is subject to hysteresis which, generally speaking, is characteristic of phase transformations. It is suggested that the processes of formation and destruction of uranium hydrides during the thermal cycling of uranium rods may be one of the causes of the variations in dimension which occur. (auth)

Radiation Effects

Refer also to abstract 22817.

22647 (AFSWP-843) DEVELOPMENT REPORT ON A MEANS OF MONITORING LABORATORY EXPOSURES TO INTENSE THERMAL RADIATION IN ACCORDANCE WITH THE GENERALIZED FIELD PULSE. Lab. Project 5046-2, Part 12. Final Report. Jefferson A. Carter (Naval Material Lab., Brooklyn). Feb. 10, 1955. 22p. (AD-270952)

To predict the behavior of organic materials, when exposed to a nuclear detonation, a laboratory source in which the irradiance is monitored in accordance with the normalized variation of intensity of irradiation with time for a nuclear detonation was designed and tested. (auth)

22648 (DC-60-2-726) 304 BORIDED STAINLESS STEEL TENSILE DATA. Richard A. Winter (General Electric Co. Aircraft Nuclear Propulsion Dept., Idaho Falls, Idaho). Feb. 3, 1960. Contract AT(11-1)-171. 15p.

Forty borided stainless steel samples, both irradiated and unirradiated, were pulled. The samples were split into two groups according to their chemical composition and a representative number of samples from each group was pulled at room temperature, 400, 800, 1200, and 1600°F. The physical properties were measured and recorded. (auth)

22649 (GEAP-3905) MARITIME LOOP IRRADIATION PROGRAM [ON] SAVANNAH I FUEL IRRADIATION. Quarterly Progress Report, October 1, 1961–December 31, 1961. D. W. Danielson and R. S. Gilbert (General Electric Co. Vallecitos Atomic Lab., Pleasanton, Calif.). Jan. 31, 1962. Contract AT(04-3)-189. 20p.

The S-I-5-B-M fuel irradiation in the GETR Maritime Loop is described. Data are summarized in tabular form. Discussions of fuel performance, water chemistry, problems with loop operations, and crud deposition are given. The loop operated continuously for the full duration of reactor operation. All water chemistry conditions were maintained within specifications with the exception of dissolved hydrogen. (M.C.G.)

22650 (HW-70643) DESCRIBING FUEL ELEMENT DISTORTION USING ORTHOGONAL POLYNOMIALS. J. L. Jaech (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 4, 1961. Contract AT (45-1)-1350. 21p.

The advantages of the polynomial method of describing fuel element distortion are discussed based on theoretical considerations and supported by data on 19 tubes. (M.C.G.)

22651 (NAA-SR-Memo-7221) AN IRRADIATION TEST OF U, U-0.04 w/o Be, U-0.2 w/o Cr, U-0.1 w/o Ce, U-0.1 w/o Y, AND U-0.2 w/o V. G. G. Bentie (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Mar. 20, 1962. Contract [AT(11-1)-Gen-8]. 11p.

Parameters of unirradiated fuel and the results of irradiating U and 5 alloying elements are given. Several samples of each alloy were irradiated in the MTR. The alloys swelled less than unalloyed U. The U–Cr alloy showed the least swelling. Several variables exist among the alloys which may result in variations in swelling: solid atoms of different size than U; fuel strength; and fuel structure. (auth)

22652 (NP-11730) MONTHLY ACCESSION LIST NO. 58 [ON RADIATION EFFECTS DATA]. (Battelle Memorial Inst. Radiation Effects Information Center, Columbus, Ohio). June 15, 1962. Contract AF33(616)-7375. 33p.

Eighty-six references on radiation effects on organic and inorganic compounds, electronics, polymers, metals, and ceramics, along with dosimetry and facilities, are given to reports and U. S. and foreign journals published from 1960 to March 1962. A separate list of 36 REIC publications is also given. (P.C.H.)

22653 (TID-16102) TRANSIENT PHOTOCONDUCTIVITY OF POLYSTYRENE AND POLYISOBUTYLENE EXPOSED TO PULSES OF NEUTRON AND GAMMA RADIATION. F. N. Coppage (Sandia Corp., Albuquerque, N. Mex.). June 1962. Contract [AT(29-1)-789]. 17p. (SCDC-2686)

Photoconductivity in polystyrene and polyisobutylene-impregnated Kraft paper dielectrics has been measured during and following exposures to short-duration, high-intensity pulses of nuclear radiation. Absorbed dose rates were $\leq 1 \times 10^7$ rads/sec. Temperatures of the dielectric samples were controlled in the range from –18 to 80°C. Radiation sources utilized were the Sandia Pulsed Reactor (SPR) and the TRIGA Mk F. The prompt reactor periods for the study ranged from 30 to 300 μsec for the SPR and 4 msec for the TRIGA Mk F. Photoconductivity in equilibrium with gamma-radiation absorbed-dose rate is characterized in organic insulating solids by $(\sigma - \sigma_0) = A\dot{R}^{\delta}$ where σ is total conductivity, σ_0 is the dark conductivity, $\dot{R}$ is the absorbed radiation intensity (rads/sec), and A and δ are empirical constants. This relationship, found valid for dose rates ≤1.6 rads/sec and for dose rates $\leq 5 \times 10^3$ rads/sec, remains valid for exposures to high-intensity, short-duration radiation pulses. Values of δ equal to 0.95 for polystyrene and 0.85 for polyisobutylene were measured. The observed magnitude of conductivity, i.e., the value of A, for a given absorbed dose rate differed with the different radiation sources. With the addition of data from a pure gamma-ray source and knowledge of the neutron-dose to gamma-ray-dose ratio for the reactor sources, it is deduced that the effectiveness of neutrons in producing photoconductivity as compared to gamma rays is negligible. (auth)

22654 (AEC-tr-5140) BEHAVIOR OF NEUTRON-IRRADIATED SINTERED BERYLLIUM OXIDE. J. Elston (France. Commissariat à l'Énergie Atomique. Centre d'Etudes Nucléaires, Saclay). Translated for Oak Ridge National Lab., Tenn. from Report DM/1182. 1962. 28p.

The effects of radiation on the crystal parameters and on the physical characteristics of beryllium oxide were studied as a function of the fast integrated flux (energy of neutrons above 1 Mev), of the irradiation temperature, and of the density of the oxide. Disintegration of sintered beryllium oxide compacts irradiated at a dose higher than or equal to 2×10^{20} n, cm^{-2} and at a temperature below 100°C is attributed to the increase of the c-parameter, which is greater than the increase of the a-parameter. A micrograph of a specimen irradiated at 9×10^{19} n, cm^{-2} ($T_p < 100$°C) showed how a loss of intergranular cohesion is produced in the sintered samples. Preliminary results on the energy liberated at 1130°C by the irradiated beryllium oxide are given, and the role of stresses which appeared in the sintered compacts as a consequence of anisotropic deformation of the crystal lattice is considered. Some results concerning the evolution of helium are also given. (P.C.H.)

22655 (AEC-tr-5181) EFFECT OF IRRADIATION AS A MATERIAL SCIENCE PROBLEM. S. T. Konobeevskii (Konobeevski) (Akademiya Nauk S.S.S.R. Metallurgicheskoi Institut im. A. A. Baikova). Translation of paper for presentation at the International Colloquim "The Impact of Science on Materials Technology," San Carlos de Bariloche, April 2-7, 1962. 22p.

The field of radiation materials is surveyed with emphasis on studies of radiation effects on materials as they contribute to our knowledge of the solid state. It is concluded that it is necessary to distinguish between phenomena involving single mobile defects and phenomena associated with larger damages. Radioinduced relaxation of elastic stresses is an example of the former, while radioinduced homogenization of alloys containing dispersed precipitates is an example of the latter. Examples discussed are addition of Pu to Cu–Sn bronze, and order in Fe_3Al. (T.R.H.)

22656 RADIATION EFFECTS ON DIFFUSION OF ZINC IN BRASS. Richard Allan Arndt (Northwestern Univ., Evanston, Ill.). Dissertation Abstr., 22: 2845(Feb. 1962).

The macroscopic diffusion of zinc in an alloy of 10% zinc-90% copper was studied under bombardment with 30 kev neon ions. The temperature dependence of the diffusion coefficient of zinc was determined in the temperature range of 207 to 316°C. The dependence of the diffusion coefficient on the bombarding flux was also determined. Diffusion coefficients obtained during irradiation were compared to those obtained from unirradiated samples. When brass was heated in a vacuum, the zinc diffused to the surface and evaporated. This depletion of zinc from 10% zinc-90% copper resulted in a 30% change in the reflection coefficient of the brass at 350 mμ. The time dependent diffusion equation was solved for the experimental conditions and the resulting zinc concentration distribution was determined. The zinc concentration distribution, for a given value of $\sqrt{Dt}$, where D is the diffusion coefficient and t is the time of the diffusion anneal, is approximated by a series of thin, homogeneous layers. Using this approximation, the resulting Fresnel coefficient, and consequently the reflection coefficient, was calculated. By applying this method to several zinc concentration distributions the reflection coefficient of the brass was calculated as a function of $\sqrt{Dt}$. The diffusion coefficient can be determined from measurements of the reflection coefficient and the annealing time by interpolating from a graph of the reflection coefficient vs. $\sqrt{Dt}$. The samples were thin strips of 10% zinc-90% copper. These were heat treated under conditions such that zinc losses can be neglected. This treatment increased the grain size to the point where measurements could be taken on single grains. The samples were electrolytically polished and etched. The neon bombardment produced defects (vacancies plus interstitials) at a calculated rate of 0.048 atomic fractions per second. At 243°C this resulted in a computed vacancy concentration under steady state of 2.2×10^{-6}. Under irradiation the average diffusion coefficient was 1.8×10^{-14} cm^2/sec and the average activation energy was 8700 cal/g mol. The diffusion coefficient showed a square root dependence on the bombarding flux. These results indicated diffusion under constant production of defects and simultaneous annealing of

defects to fixed sinks plus direct recombination. Without irradiation the average diffusion coefficient was 2.7×10^{-15} cm²/sec at 243°C and the average activation energy was 27000 cal/g mol. These low values, compared to other experiments, indicated inhomogeneous diffusion along short circuit paths such as dislocations. Samples that were cold worked by mechanical grinding showed diffusion coefficients a factor of 10 greater. These cold worked samples, however, exhibit inhibited diffusion during irradiation. The heavy ion bombardment erased the effects of the previous history of the sample. The conclusion is that radiation-enhanced bulk diffusion is observed under heavy ion bombardment.

22657 DEFECT PRODUCTION, INTERNAL FRICTION AND YOUNG'S MODULUS IN IRRADIATED TUNGSTEN. Daniel Robert Muss (Univ. of Pittsburgh). Dissertation Abstr., 22: 4059(May 1962).

The effect of 10 to 14 Mev deuteron irradiation on tungsten was studied experimentally. Two aspects of this problem were examined. The first was a study of the incident deuteron energy dependence of defect production; the second was a study of the effect of radioinduced defects on mechanical properties. The change in the electrical resistance of the metal with bombardment was used to study the rate of defect production. The rate of defect production in tungsten is shown experimentally to depend on the energy of the incident deuteron almost as 1/E. This result was compared with a theory for defect production in metals by charged particle irradiation. The small deviation of the experimental results from a 1/E dependence was in a direction opposite to the deviation from a 1/E dependence predicted from a hard sphere model for secondary defect production. The results of measurements of internal friction and Young's modulus as a function of temperature and incident 14 Mev deuteron flux are presented. Evidence is given for the association of at least a part of the internal friction in tungsten with dislocations. A Bordoni-dislocation relaxation peak was observed; a fit of the Bordoni peak data to a single activation energy relaxation model gave a value of 0.21 ev for the activation energy, and a value of 1.5×10^{13} cps for the attempt frequency. The Bordoni peak is shown to be generally reduced in height by irradiation at 300°K; after irradiation, several smaller, sharper peaks appear. Data are given showing a decrease in internal friction and an increase in Young's modulus with irradiation at 300°K. This effect saturates at a flux of 1×10^{16} deuterons/cm². The decrease in internal friction and the increase in Young's modulus with irradiation are attributed to the pinning of dislocations by radiation induced interstitials. At 300°K Young's modulus decreased linearly with incident flux in the range 1×10^{16} to 1×10^{17} deuterons/cm². This linear decrease was attributed to the bulk effect of radioinduced vacancies frozen into the lattice at 300°K. A value of 0.44% change in Young's modulus per atomic per cent of vacancies was deduced from these data; this value was compared with Dienes' prediction of 1.0%. The effect of irradiation at 79°K on internal friction in tungsten was studied. A series of very high, very sharp peaks in the internal friction vs. temperature curve are reported for the anneal of the sample to 300°K. These peaks were not present during subsequent measurements of internal friction vs. temperature. It is suggested that these internal friction annealing peaks might arise from thermal activated motion of interstitials.

22658 INVESTIGATION CONCERNING THE BEHAVIOR OF ELECTRONIC STRUCTURAL PARTS DURING AND AFTER THE ACTION OF GAMMA RADIATION. A. Bartl (Institut für Angewandte Physik der Reinststoffe, Dresden). Isotopentechnik, 2: 116-24(Apr. 1962). (In German)

The behavior of the most important electronic structural elements such as resistors, condensers, inductance, as well as high-vacuum and gas-filled tubes under the influence of gamma radiation was investigated. From that resulted definite conclusions for the usefulness of such structural elements in apparatus, which are exposed to gamma radiation. Various electronic structural groups were built of structural parts which change their electrical properties only slightly up to very high radiation doses, and their operational manner investigated during a long interval in the radiation field. (tr-auth)

22659 EFFECTS OF γ RADIATION ON DIELECTRIC LOSSES IN MICA CONDUCTIVITY. K. A. Vodop'yanov and I. G. Vorozhtsova (Tomsk State Univ., USSR). Izvest. Vysshikh Ucheb. Zavedenif, Fiz., No. 1, 48-51(1962). (In Russian)

The influence of γ radiation on dielectric properties was determined at 20 to 300°C and frequencies of 50 to 10^4 Kertz. The conductivity of irradiated specimens is reduced at 20 to 100°C and increased at higher temperatures. Water radiolysis in loose muscovite improves the dielectric properties of mica. (R.V.J.)

22660 FISSION FRAGMENT TRACKS IN METAL FILMS. T. S. Noggle and J. O. Stiegler (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 33: 1726-30(May 1962).

Fission fragment tracks observed in electron microscope studies of platinum and palladium films are interpreted in terms of thermal processes involving melting and vaporization. The results require that the energy lost by the fragment be converted into thermal energy over the entire volume of the track in a time short enough that little of it is conducted away. A model in which free electrons disperse the energy over this volume is used to account for the widths and structures of the tracks. (auth)

22661 INTERNAL FRICTION AND YOUNG'S MODULUS IN IRRADIATED TUNGSTEN. D. R. Muss and J. R. Townsend (Univ. of Pittsburgh). J. Appl. Phys., 33: 1804-7(May 1962).

Measurements of internal friction and Young's modulus as functions of temperature and 13.7-Mev deuteron bombardment flux are reported for polycrystalline tungsten. A dislocation-relaxation peak in the internal friction as a function of temperature is observed. The peak height is found to be reduced by irradiation. The background internal friction decreases and the modulus increases with bombarding flux. The experimental results for modulus change with bombardment is shown to fit a simple dislocation pinning model. The effect of immobile radiation-induced vacancies on Young's modulus in tungsten is observed to be −0.44% per atomic percent of vacancies. (auth)

22662 RADIATION EFFECTS IN CaF2 : Sm. J. R. O'Connor and H. A. Bostick (Lincoln Lab., Massachusetts Inst. of Tech., Lexington). J. Appl. Phys., 33: 1868-70 (May 1962).

The absorption spectra of Sm^{3+} and Sm^{2+} in CaF_2 are measured from 200 to 800 mμ at room and liquid-nitrogen temperatures. A strong divalent absorption band at 620 mμ has an effective oscillator strength of 1.1×10^{-2}. This band is used to study the reduction of $CaF_2:Sm^{3+}$ by ionizing radiation. For some samples, the reduction is as large as 50%. The kinetics of the reduction is obscured as a result of the presence of oxygen and other crystal defects. The data indicate that the charge compensator for Sm^{3+} in CaF_2 is an interstitial F^- ion. (auth)

22663 MECHANICAL MODELS FOR TUBULAR REACTOR FUEL ELEMENTS. K. R. Merckx (General Electric

Co., Richland, Wash.). J. Basic Eng., 83: 247-56(June 1962).

Cladding deformations were calculated using two models for tubular metallic reactor fuel elements. In the first model, the cyclic dependence of the expansion history was neglected and the strength of both the fuel and cladding materials was accounted for by using equations based on plastic-deformation theory. Exterior cladding deformations did depend on fuel geometries, but were relatively independent of the strength of the fuel material. In the second model, the strength of the fuel material was neglected, but the cyclic dependence of the expansions of the cladding material was accounted for. This model predicted that minus the ratio of the inner-to-exterior cladding strain is equal to the ratio of the inner-to-outer radii times outer-to-inner cladding thicknesses raised to the $(1/1-n)$ power for cladding materials with stresses, S, related to strains, E, by $S = AE/E^n$. (auth)

22664 RADIATION DOSIMETRY USING HIGH POLYMERS. N. Kishi. Kôbunshi, 9: 95-8(Feb. 1960).

The properties of high polymers, which can be used for dosimetry, are color changes, luminescent and scintillation effects, polymerization and depolymerization effects, and gas evolving reactions. Results obtained from the literature for each property are reviewed. (OID)

22665 THE EFFECTS OF RADIATION ON THE VISCOELASTIC PROPERTIES OF TEXTILE MATERIALS. Kiichiro Sakaoku. Kôbunshi, 9: 1049-53(Dec. 1960).

The theoretical relationship between the viscoelasticity of textile materials and irradiation is discussed. The changes in the kinematic elasticity of polyethylene, nylon 66, nylon 6, saran, and polyethylene terephthalate with varying radiation doses are discussed, and graphical data are shown for the elasticity losses, annealing effects, and molecular chain scission effects by irradiation. (OID)

22666 IMPROVING THE PROPERTIES OF HIGH POLYMER MATERIALS FOR INSULATED WIRES BY IRRADIATION. Setsuya Isshiki and Yasusada Sekiguchi. Kôbunshi, 10: 703-8(Aug. 1961).

The effects of irradiation on polyethylene and polyvinyl chloride, the irradiation facilities, and the industrial production of insulated wires are discussed. The NST (no strength temperature) of a polyethylene sample having a 2-g/sq mm load increased suddenly at 10^6 rad and increased to 250°C at a dosage of 10^7 rad. The number of network chains increased rapidly from 10^6 rad. A radiation dosage of $\sim 5 \times 10^6$ rad was required in order to obtain a thermally improved polyethylene. An increase of ~30 to 40°C in the thermal-softening temperature and ~200°C increase in the line short-circuit temperature were obtained with an irradiated polyethylene-coated wire. When polyvinyl chloride was irradiated at a high dosage, crosslinking and chain scission occurred at the same time. However, by incorporating other monomers, the crosslinking of polyvinyl alcohol (PVA) can be improved in the lower dosage range. Thus, solvent resistivity, thermal-softening resistivity, and compression resistivity of PVA can be improved. Problems associated with the uniform irradiation of materials are discussed. (OID)

22667 THE EFFECTS OF RADIATION ON POLYETHYLENE. I. THE EFFECTS OF RADIATION ON THE VISCOELASTICITY. Sanyo Hori. Nagoya Kôgyô Gijutsu Shikensho Hôkoku, 10: 162-9(Mar. 1961).

The concentration of crosslinkages was determined by measuring the visco-elasticity of γ-irradiated polyethylene (using 3 kc of Co^{60} at 4.2×10^5 r/hr up to dose of 10 to 160 Mr) in the rubber elasticity temperature range (room temperature or 150°C) with a creep tester. Results indicated that (1) the concentration of crosslinkages in the melted state was proportional to the radiation dose; (2) after irradiation, the saturation value reached in the crystalline state varied with respect to the type of polymer (linear < branched) or to the heat treatment condition (slowly cooled < quenched); and (3) branched polyethylene decomposed more easily than linear polyethylene. (OID)

22668 THE EFFECTS OF RADIATION ON POLYETHYLENE. II. THE EFFECTS OF RADIATION ON THE CRYSTALLIZATION PROPERTIES. Sanyo Hori. Nagoya Kôgyô Gijutsu Shikensho Hôkoku, 10: 234-40(Apr. 1961).

The specific heat- and specific volume-temperature relationships of polyethylene irradiated with γ rays were determined, and the depression of the melting temperature of the irradiated polyethylene is discussed. The melting temperature of polyethylene irradiated at room temperature decreased with increasing radiation dosage up to 40 Mr, but it did not decrease above this radiation dosage because of the saturation of the concentration of crosslinkages. The melting temperature of the quenched polymer irradiated at room temperature decreased much more than that of a slowly cooled polymer because the number of amorphous regions to be crosslinked was increased by quenching. The melting temperature of the polymer decreased much more by irradiation in the molten state than in the solid state, but the lowering of the melting temperature in the molten state did not stop at 50 Mr because of the absence of the crystalline region in which crosslinking did not occur in the molten state. (OID)

22669 THE EFFECTS OF RADIATION ON POLYETHYLENE. III. THE EFFECTS OF RADIATION ON THE CRYSTALLIZATION VELOCITY. Sanyo Hori. Nagoya Kôgyô Gijutsu Shikensho Hôkoku, 10: 318-23(May 1961).

The crystallization velocity was measured from the rate of volume contraction following the crystallization. The crosslinking of irradiated polyethylene interfered with the spherulite growth and decreased the Avrami coefficient. The framework of molecules in the irradiated period did not disappear in the molten state when the concentration of crosslinkages was sufficiently high. Then the same crystals in the irradiated period were observed after the period of crystallization in cooling. Since the Avrami coefficient is approximately one, the type of crystallization is a linear crystal growth and not spherulite growth. The interference of branches in spherulite growth could not be measured in a small number of branches because these polymers were not obtained generally. (OID)

22670 THE EFFECTS OF RADIATION ON POLYETHYLENE. IV. THE EFFECTS OF RADIATION ON THE SIZE OF THE CRYSTALLITE. Sanyo Hori. Nagoya Kôgyô Gijutsu Shikensho Hôkoku, 10: 369-74(June 1961).

The crystallite size of γ-irradiated polyethylene at room temperature or in the melted state is discussed with respect to the concentration of the crosslinkages. The distribution curve for the crystallite size vs the temperature dependency of specific heat was obtained by assuming that the crystallite size was equal to the molecular length of the paraffin. The results were that the crystallite size (1) decreased with increasing dosage below 40 Mr, but above this dosage the concentration of crosslinkages was saturated when irradiation was carried out at room temperature, and (2) decreased ultimately with increasing dosage because crosslinking was not restricted in the melted state. (OID)

22671 SOME FACTORS INFLUENCING DISLOCATION LOOP SIZE IN NEUTRON-IRRADIATED METALS.

S. S. Sheinin (Imperial Coll. of Science and Tech., London). Nature, 194: 1272-3(June 30, 1962).

A brief discussion is given of the factors influencing dislocation loop size in irradiated metals, particularly the stacking fault energy and the rate of production of point defects. A model for understanding the effect of the factors is described. (D.L.C.)

22672 THERMOLUMINESCENCE STUDIES OF THE GAMMA-RAY IRRADIATED FERROELECTRICS ROCHELLE SALT AND GUANIDINE ALUMINUM SULFATE HEXAHYDRATE. J. W. Gilliland, Jr. (Vanderbilt Univ., Nashville), and H. P. Yockey. Phys. and Chem. Solids, 23: 367-74(Apr. 1962). (In English)

Samples of Rochelle salt and guanidine aluminum sulfate hexahydrate were irradiated with Co^{60} gamma rays up to 3.5×10^6 r at liquid nitrogen temperature, after which they were warmed at a constant rate and observed with a photomultiplier tube. The grade Rochelle salt powder was found to produce a glow peak at about −61°C, corresponding to a trap depth of about 0.42 ev, which was removed completely by two recrystallizations from water solution. Rochelle salt single crystals also yielded no detectable thermoluminescence, indicating a maximum trap concentration significantly less than 10^6 per gram. Guanidine aluminum sulfate hexahydrate showed three glow peaks, at −146, −119, and about −5°C, corresponding to trap depths of 0.25, 0.31, and 0.54 ev respectively. The major peak at −146°C became more prominent as the dose was increased to 3.5×10^6 r. At low doses (10,000 r) the −119°C peak was largest but became completely concealed by the lower temperature peak at 3.5×10^6 r. The low and very broad peak at −5°C was most easily seen at intermediate doses of 10^5 and 10^6 r, becoming undetectable at lower doses and becoming poorly resolved at higher doses. Trap concentration for an exposure of 3.5×10^5 r was estimated to be 7×10^9 per gram. (auth)

22673 GAMMA IRRADIATION EFFECTS ON ELECTRETS. Bernhard Gross and R. J. de Moraes (Universidade Católica, Rio de Janeiro). Phys. Rev., 126: 930-2 (May 1, 1962).

Carnauba wax electrets were irradiated with gamma rays from a Co^{60} source. Doses varied between 0 and 5 megaroentgen (Mr). After irradiation, the polarization of the electrets was determined by reheating them in short circuit and measuring the released charge. This charge decreased roughly exponentially with dose, with a decay constant of the order of 1 Mr. A background effect from Compton polarization is described. (auth)

22674 THE SELF-TRAPPED HOLE IN CaF_2. W. Hayes and J. W. Twidell (Clarendon Lab., Oxford). Proc. Phys. Soc. (London), 79: 1295-6(June 1, 1962).

Upon x-irradiation of CaF_2: Tm crystals in a microwave cavity at 80°K, the self-trapped hole is produced. This center is closely related to the F_2^- center in LiF. The intensity ratio of the center in CaF_2 is 10 after 10 min, and 5 after 30 min irradiation. Electron trapping by Tm impurities increases the initial rate of production of the center. The formation of the self-trapped hole in CaF_2: Y is suppressed because Y impurity ions introduce deep hole traps into the lattice. (L.N.N.)

22675 THE EFFECTS OF Co^{60} γ-RAYS ON THE VISCO-ELASTIC DISPERSION OF SEVERAL TEXTILE MATERIALS. Kiichiro Sakaoku. Sen-i Gakkaishi, 17: 590-4(July 1961).

The results obtained were (1) saran showed degradation with increasing radiation doses, its dynamic modulus decreased with melting of fine crystallites, and the dispersion peak of the loss-tangent shifted to a lower temperature; (2) nylon 6 showed an increase in the dynamic modulus up to 5×10^7 rep at 25°C and a decrease at 10^8 rep when compared with that of an unirradiated sample. Hence, the crosslinking effect of nylon 6 was dominant up to a dosage of 10^7 rep. The dynamic modulus of crystalline polyethylene terephthalate increased with irradiation dosages up to 10^9 rep and with practically no change in the loss tangent. It was concluded that the annealing effect induced by irradiation was not related to crosslinking or degradation. (OID)

22676 CONCERNING THE THEORY OF ANNEALING OF RADIATION DEFECTS. B. Ya. Yur'kov (Lebedev Inst. of Physics, Moscow). Soviet Phys.-Solid State, 3: 2591-6 (June 1962).

An analysis is made of the annihilation of homo- and heterogeneous pairs during the radiation annealing process. A solution is found for heterogeneous pairs that gives a good description of the process for long annealing times (greater than 50 min at 350°C). In this case, a value of capture radius is obtained that is approximately equal to the lattice constant. The second solution of Waite, which corresponds to annihilation of homogeneous pairs and which is advanced to explain annealing for short times (up to 50 min), does not agree with experiments on annealing of silicon. For this case, a solution that satisfies the experimental relations is derived. (auth)

22677 THE EFFECT OF PLASTIC DEFORMATION AND IRRADIATION ON THE INTERNAL FRICTION OF LiF SINGLE CRYSTALS. N. A. Tyapunina, M. P. Shaskol'skaya, Chao-chien, and Yu. Kh. Vekilov (Mosco Steel Inst., USSR). Soviet Phys.-Solid State, 3: 2643-7(June 1962).

Changes in internal friction (at a frequency of ~100 kc) and dislocation density are measured in relation to the previous loading of LiF single crystals, both unirradiated and x-irradiated. The experimental results are explained qualitatively in terms of the dislocation theory of internal friction. (auth)

22678 IN-PILE ELECTROCHEMICAL CORROSION MEASUREMENTS. G. J. Spaepen and A. H. Willis (Centre d'Études de l'Énergie Nucléaire, Mol, Belg.). IAEA Preprint CN-13/36. 17p. (In English)

To be published in the Proceedings of the IAEA Conference on the Corrosion of Reactor Materials held in Salzburg, 4-9 June 1962.

A technique is described for introducing a three-electrode electrochemical cell into a channel of the BR 1 reactor. The choice of materials for construction of the in-pile devices is discussed. A description is given of potentiodynamic tests on stainless steel and of transitmetric tests on aluminium and its alloys. The possible applications of the installation are summarized. (auth)

22679 COMPARISON OF IRRADIATION DAMAGE IN ARTIFICIAL AND NATURAL GRAPHITE AT DIFFERENT IRRADIATION TEMPERATURES. R. Gain (Kernforschungsanlage Jülich, Ger. and Institut für Reaktorwerkstoffe, Aachen). IAEA Preprint SM-25/3. 18p. (In English)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials held in Venice, Italy, 7-11 May 1962.

Results of irradiation experiments on artificial and natural graphite in three temperature intervals ranging from 70 to 150°C, 300 to 400°C, and 550 to 650°C are compared. These irradiation experiments were carried out in core or pool positions of the GETR Vallecitos. The investigated samples received neutron doses up to 5×10^{21} nvt

with E > 0.17 ev, which is approximately 3×10^{21} nvt with E > 0.18 Mev. Changes in the lattice parameters, the electric and thermal conductivity, the macroscopic dimensions, and the bending strength are discussed. The natural graphite samples investigated were manufactured partly with, partly without a binding material. Results obtained during these investigations indicate, in addition to the dependence on the irradiation temperature and the neutron dose, a strong influence exerted by the basic materials, the treatment during production and the density. Strong anisotropic effects in natural graphite at lower irradiation temperatures, resulting from the treatment during production, level out at higher irradiation temperatures. (auth)

22680 RADIATION EFFECTS IN THIN FILMS. C. Motoc and I. Teodorescu (Institutul de Fizica Atomica, Academia R. P. R., Bucharest). IAEA Preprint SM-25/7. 18p. (In English)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials held in Venice, Italy, 7-11 May 1962.

Thin films of Au, Cu, Ag, and Ni were irradiated in the V.V.R.S. reactor at 60°C, and the structure before and after irradiation was examined by electron diffraction or electron microscopy. The neutron doses were in the range of 10^{17} to 10^{18} nvt. The films were deposited on glass and quartz substrates as well as on copper and nickel grids covered by a collodion grid and were irradiated in evacuated phials or in phials filled with oxygen or inert gases. As a result of irradiating in vacuum or inert gases thin films of Au and Ag on Cu grids, different alloys such as AuCu, $AuCu_3$, and AgCu were formed. No alloys were observed on thin films deposited on Ni grids. Radiation effects in thin films irradiated in oxygen resulted in a thorough oxidation associated with the phenomenon of alloy formation for the thin films deposited on Cu grids. By irradiating Cu, Ag, and Ni films, diffraction patterns of Cu_2O, CuO and $(CuO)'$, AgO, Ag_2O_3, and NiO were found. By irradiating Au films on Cu and Ni grids, different diffraction patterns very similar to those observed by Shishakow were observed. These may arise either from the oxidation of Au or from the oxidation of impurities in the specimens or in the grid. Some order-disorder phenomena were also observed: a hexagonal structure of Ni, the colloidal form of Au as reported elsewhere and a hexagonal structure of Ag, very similar to the structure reported by Bublick. The order-disorder and the alloy formation mechanisms may be due to an enhanced diffusion associated with the thermal spike phenomena as a result of irradiation. (auth)

22681 EFFECTS OF NEUTRON IRRADIATION ON THE STRUCTURE AND MAGNETIC PROPERTIES OF MANGANESE AND LITHIUM FERRITES OF HIGH PERMEABILITY. E. Labusca, N. Andreescu, and C. Motoc (Institutuul de Fizica Atomica, Academia R. P. R., Bucharest). IAEA Preprint SM-25/9. 22p. (In French)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials held in Venice, Italy, 7-11 May 1962.

Magnetic materials (ferrites) of complex composition $aFe_2O_3 \cdot bZnO \cdot cMe_1O \cdot dMe_2O$ (where Me_1, Me_2 and Li, Mn, or Mg) were irradiated in the V.V.R.S. reactor at 32°C. The neutron doses were in the range of 10^{16} to 10^{18} nvt. Both ferrites with rectangular hysteresis loops and with high permeability ($\mu_{in} \approx 3000$) were irradiated. The irradiation did not influence to a great extent the specific properties of the ferrites with rectangular hysteresis loops. The influence was greater for those with high values of Kr for which the values of μ and Kr are found to decrease. The ferrites with low values of Kr are very weakly influenced by irradiation. For the ferrites with high permeability irradiated to neutron doses higher than 5×10^{17} nvt, a 20 to 30% decrease of the permeability in the range of magnetic fields below 0.2 gauss was found. These effects are due only to neutron irradiation because during irradiation the temperature of the samples was below 36°C. The study by electron microscopy of the structure of the samples before and after irradiation showed the existence of some structural defects which may be due to dislocations as well as to the precipitation of an isolated phase from the bulk, so that the structure's degree of homogeneity has changed. As has been shown elsewhere this effect has a decisive influence on the high values of μ and Kr. Changes in the crystalline structure determine changes in the displacements of the Bloch walls as well as changes in the shape and the surface of the magnetic domains, as can be seen from some observed structural effects. Finally, the conditions in which these materials could be used in devices working in radiation fields are established. (auth)

22682 EFFECT OF NUCLEAR RADIATION ON THE ELECTRICAL CONDUCTIVITY OF CHROMIUM SESQUIOXIDE (Cr_2O_3). M. Nachman and L. Cojocaru (Institutul de Fizică Atomică, Academia R. P. R., Bucharest). IAEA Preprint SM-25/12. 16p. (In English)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials held in Venice, Italy, 7-11 May 1962.

Studies were made of the variation with temperature of the electrical conductivity (measured in direct current) of sintered pellets of Cr_2O_3 before and after irradiation in a nuclear reactor. It was established that, after samples are irradiated in an integrated neutron flux of about 10^{17} nvt, their conductivity is appreciably reduced, whereas the activation energy of the conductivity remains practically constant. Since Cr_2O_3 is a p-type semi-conductor, the results obtained can be explained on the assumption that the defects introduced into the Cr_2O_3 lattice by irradiation produce donor levels which help to reduce the initial concentration of the holes. (auth)

22683 THE EFFECTS OF ELECTRON IRRADIATION ON THE INTERNAL FRICTION OF COPPER. J. N. Lomer, E. W. J. Mitchell, and D. H. Niblett (Univ. of Reading, Eng.). IAEA Preprint SM-25/15. 21p. (In English)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials held in Venice, Italy, 7-11 May 1962.

The internal friction of a copper strip of 99.999% purity was measured at about 0.5 kHz before and after electron irradiation at both room and liquid nitrogen temperatures. Measurements were also made during warm-up. The main results are: (1) A small change at 100°K, only detectable after relatively high electron doses. (2) A change during warm-up, beginning at about 200°K, the precise temperature being variable. (Stage II of defect mobility.) No effect was observed at 140°K, the temperature at which Martin observed a second step in the Stage II annealing of the electrical resistance. (3) A further change beginning at about 265°K. (Stage III of defect mobility.) (4) For the room temperature irradiations, the variation with dose and energy, although showing considerable scatter, was consistent with a displacement energy in the range 20 to 30 ev. A discussion of the results in terms of theoretical ideas about these processes is given. (auth)

22684 MEASUREMENTS OF MECHANICAL PROPERTIES OF IRRADIATED GRAPHITE BY MEANS OF THE

ULTRASONIC PULSE METHOD. Sennosuke Satô (Japan Atomic Energy Research Inst., Tokyo). IAEA Preprint SM-25/17. 35p. (In English)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials held in Venice, Italy, 7-11 May 1962.

The measurement of propagation velocity of pulsed ultrasonic waves through material is proposed as a means of determining the elastic modulus. Compared to other methods, such as direct mechanical testing and elastic resonance determination, the ultrasonic method has the unique advantage of being easily applied to test pieces of all forms and to tests at all temperatures, even up to about 1600°C. The graphite specimens used in the present series of tests were (1) extruded (TAG-1), (2) press-molded from pitch coke (TAG-2), both from Lock Port coke, and (3) press-molded from pitch coke (TAG-3). Irradiation was undertaken at Hanford, in a helium-filled aluminum capsule, with dose of 5.8×10^{20} nvt at 30°C, and 7.2×10^{20} nvt at 80°C. The specimens were subjected to mechanical tests and to tests for determining the elastic modulus. A close correlation between the two properties was revealed, indicating the possibility of estimating mechanical strength from elastic modulus irrespective of the irradiation dose. Thermal annealing tends to rearrange the clusters of interstitial atoms produced through irradiation into more stable clusters and in part disintegrates and annihilates the interstitial clusters which recombine with the vacant sites. This leads to elastic recovery. The present study, in which the ultrasonic method is applied to high temperature measurements, throws light on elastic recovery through determination of the elastic modulus subsequent to isochronal and isothermal annealing. (auth)

22685 THE FORMATION OF VACANCIES IN LiF CRYSTALS BY REACTOR IRRADIATION. K. Kubo and K. Ozawa (Japan Atomic Energy Research Inst., Tokyo). IAEA Preprint SM-25/18. 19p. (In English)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials held in Venice, Italy, 7-11 May 1962.

When a LiF crystal is irradiated in a nuclear reactor, vacancies are formed in addition to those initially existing in the crystal before irradiation by the following possible mechanisms: displacement of atoms from the LiF crystal lattice site by (1) incident fast neutrons, (2) α-particles and tritons with energies of 2.06 and 2.74 Mev respectively (resulting from the (n,α) reaction caused by incident thermal neutrons, for which Li^6 has a large absorption cross section), (3) photoelectrons produced by γ rays in the reactor, (4) evaporation from dislocation jogs (Seitz's mechanism), and (5) generation by multiple ionization (Varley's mechanism). Since a negative ion vacancy changes to an F-center after trapping an electron, the concentration of F-centers is an indication of the concentration of vacancies, and the growth curves of F-centers (F-center concentration vs irradiation dose) should represent the manner of vacancy formation by irradiation. The irradiation experiments were carried out using the JRR-1 reactor and the Co^{60} irradiation facility under various conditions. The growth curves of F-centers were obtained by the measurement of optical absorption of irradiated LiF crystals and induced activity of an Au foil irradiated together with the crystal. γ-dosimetries were also made in some of the cases using reactor irradiation. Analysis of the growth curves indicates that the mechanisms (1) and (2) are predominant in the reactor-irradiated LiF crystal and that the rates of F-center formation by fast and thermal neutrons depend on the intensity of γ rays which coexist with neutrons in the reactor, though the γ rays are rather too weak in dose and in energy to produce appreciable amount of F-centers by themselves. This can be confirmed from the formation rate of F-centers obtained by γ-ray irradiation from Co^{60} and information on the F-center distribution. X-ray measurements of the lattice parameter increase by reactor irradiation were also made. The resulting formation rates of the vacancies obtained by both optical and x-ray measurements show a reasonable agreement. (auth)

22686 A NEW MODEL OF RADIATION DAMAGE TO GRAPHITE. T. Iwata and H. Suzuki (Japan Atomic Energy Research Inst., Tokyo). IAEA Preprint SM-25 19. 29p. (In English)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials Held in Venice, Italy, 7-11 May 1962.

Hennig and Hove proposed a model of radiation damage to graphite at the first Geneva Conference and attributed the so-called Wigner energy release around 200°C to the reaction of single interstitials forming C_2 molecules. A new model is proposed as follows: (1) Single interstitial atoms migrate easily far below the liquid nitrogen temperature. They gather to make clusters (atomic clusters) where each atom has about a 10Å separation. This distance is shown to be elastically stable. (2) C_2 molecules (partially C_3 molecules) are formed from atomic clusters between 80°K and 110°K. The reverse annealing of electrical resistivity in this temperature range is explained by the help of electronic band structure. (3) C_2 molecules migrate and form the clusters consisting of molecules (molecular clusters) above 160°K. Larger clusters are made at higher temperatures. Each molecule in the clusters is held together by bonds which are much weaker than ordinary covalent bonds and by the elastic forces due to strained layers. (4) Molecular clusters may decompose to constituent molecules around 200°C and above. C_2 molecules then recombine with vacancies or escape to surfaces, causing energy release. The striking energy release around 200°C is caused by the disappearance of C_2-C_2 molecular clusters. As the temperature is raised, these clusters are further decomposed. Its decomposition is completed below 1000°C. (auth)

22687 EFFECTS OF NEUTRON IRRADIATION ON NON-FISSIONABLE ALLOYS. A. C. Damask (Brookhaven National Lab., Upton, N. Y.). IAEA Preprint SM-25/20. 28p. (In English)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials held in Vencie, Italy, 7-11 May 1962.

Neutron irradiation can cause three major effects in non-fissionable alloys: (1) the excess vacancies produced by irradiation can accelerate diffusion; (2) point defects and regions of strain can serve as additional nucleation sites for phase changes; (3) the displacement of atoms may cause a breakup of ordered or precipitated regions. By the proper choice of alloy systems, the first two effects were isolated and examined in detail. Essentially pure enhanced diffusion can be achieved in short-range ordering alloys such as the α-phase of Cu–Zn and Cu–Al. A quantitative theory was developed which shows that the temperature and flux dependence of enhanced diffusion varies with the relative amounts of excess vacancies and of their trapping sites in the solid. The predictions of the theory for high trapping site concentration were verified in Cu–Zn by neutron irradiation, and those for the low trapping site concentration by positive ion bombardment. Experiments on Cu–Al indicate that the low trapping site case can be

achieved in this alloy with neutrons. These experiments also show that by controlled irradiation an alloy can be put into a low-temperature state which cannot be achieved by thermal means alone. The change in the number of nucleation sites was studied in the Fe–C system. Since the carbon diffuses interstitially the diffusion rate cannot be accelerated, and no precipitated regions exist in freshly quenched specimens. Therefore, all changes in the rate of disappearance of carbon from solution must be related to trapping, viz., nucleation phenomena. After a few hours irradiation at ambient temperature, internal friction measurements of the carbon peak showed that it disappears ten times faster than the thermal rate. The implication that ten times the nuclei are present is confirmed by electron microscope studies. After several days irradiation at low temperature, however, the rate of disappearance of carbon from solution is one thousand times the thermal rate and is governed precisely by the activation energy for diffusion of carbon in iron. Detailed studies of this phenomenon with electrical resistivity measurements show several decay steps which are related to the interaction of the carbon atoms with point defects. (auth)

22688 THE SELF-IRRADIATION OF PLUTONIUM AND ITS DELTA ALLOYS. C. E. Olsen, R. O. Elliott and T. A. Sandenaw (Los Alamos Scientific Lab., N. Mex.). IAEA Preprint SM-25/27. 44p. (In English)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials held in Venice, Italy, 7-11 May 1962.

Electrical resistivity and heat capacity measurements have shown that self-irradiation from the alpha activity in plutonium produces damage at low temperatures. Measurements were made on specimens of nominally pure, α-phase plutonium and on specimens of plutonium-rich, δ-phase, solid-solution alloys containing aluminum. The resistivity was found to increase linearly with time at 20.1° and 4.5°K in both phases, but the rates of increase in α-phase are significantly higher than in δ-phase. Annealing of stored damage was studied by means of electrical resistivity and heat capacity measurements, and the results from both types of measurements are in concordance. Calculations by Vineyard on self-irradiation damage in plutonium are presented, and differences in radiation damage behaviors of α-phase and δ-phase are discussed and correlated with differences in other physical properties of these phases. (auth)

22689 RADIATION DAMAGE IN BeO. G. W. Keilholtz, J. E. Lee, Jr., R. P. Shields, and W. E. Browning, Jr. (Oak Ridge National Lab., Tenn.). IAEA Preprint SM-25/32. 14p. (In English)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials held in Venice, Italy, 7-11 May 1962.

The stability of BeO bodies under irradiation is under examination at the Oak Ridge National Laboratory. Cylindrical specimens, encapsulated in stainless steel and installed within an annulus through which a mixture of argon and helium is circulated to achieve temperature control, have been irradiated in the Engineering Test Reactor, Arco, Idaho. Specimens have been exposed to total fast (>1 Mev) neutron dosages from 10^{20} to 2.6×10^{21} n/cm^2 at temperatures over the range 100 to 1100°C. In addition to observation of gross changes, specimens were examined by the techniques of x-ray diffraction, optical microscopy, metallography, and electron microscopy; some specimens were dissolved for determination of their contained tritium and helium. Greatest damage appears in bodies irradiated to high neutron dosages at low temperatures. Specimens receiving as much as 1.5×10^{21} n/cm^2 at about 110°C disintegrated to powder. Fractures were observed in specimens irradiated to 2.6×10^{21} n/cm^2 at 800 to 950°C. Some specimens exposed to intermediate dosages at intermediate temperatures have survived intact. Significant structural differences which depend on irradiation temperature and on fabrication technique were observed on examination of the bodies by x-ray diffraction. Diffraction patterns of both hot- and cold-pressed irradiated BeO indicate anisotropic lattice expansion ratios $(\Delta C/C_0)/(\Delta a/a_0)$ of approximately 9. X-ray patterns of BeO irradiated at 100°C resemble those reported for irradiated graphite. The data may be interpreted as showing, in addition to isolated point defects, the presence of small (10-20 atom) discs of interstitial atoms (such as Be, He, O) in semi-regular array between closely packed planes. Strain energy in such a lattice should be high. Annealing of radiation damage effects was observed at sufficiently high temperatures. Helium found in the specimens increases directly with exposure to about 1.6×10^{21} n/cm^2 and appears to level, with higher dosages, at about 400 μl per gram of BeO; neither irradiation temperature nor extent of specimen fracture markedly affect retention of He. Tritium content is very low in specimens irradiated at temperatures above 450°C but is proportional to the square of the neutron dosage for irradiations at lower temperatures. Thermal conductivity of the BeO was decreased on irradiation as indicated by changes in the temperature gradient across specimens as the exposure progressed. Howveer, since no sudden discontinuities in the temperature gradient were observed, and since more than 25 samples survived the thermal cycling without cracking, thermal stress seems unlikely as the sole cause of failure. Atomic displacements or buildup of gas within the crystal or a combination of these appear to be the primary cause of failure of the bodies. Further experiments designed to permit a better separation of the several experimental variables are in progress. (auth)

22690 ROLE OF CARRIERS IN THE DAMAGE MECHANISM IN GERMANIUM. J. W. MacKay and E. E. Klontz (Purdue Univ., Lafayette, Ind.). IAEA Preprint SM-25/35. 17p. (In English)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials held in Venice, Italy, 7-11 May 1962.

The annealing behavior of germanium after irradiation at liquid helium temperature suggests that the primary defect produced by 1.0 Mev electron irradiation is a metastable configuration of a close vacancy-interstitial pair. When produced at higher temperatures this pair may either recombine or dissociate to form stable defects. The close pair appears to introduce only a single acceptor state in the forbidden band. When this state is occupied by an electron the pair is more stable against recombination and is more likely to dissociate into stable defects. The concentration of free electrons in the crystal determines the time required for a newly formed pair to capture an electron. If the metastable defect captures an electron before the pair recombines, then the probability of formation of a stable defect is enhanced. Thus, in a certain temperature range, electron concentration is a critical parameter in the mechanism of defect formation in germanium. This model can be invoked to explain, at least qualitatively, the relative immunity of p-type Ge to radiation damage as compared to n-type at liquid nitrogen temperature and below, and serves as a basis for understanding the strong dependence of the efficiency of damage on irradiation intensity that is observed in n-type Ge at liquid nitrogen temperature. (auth)

22691 THE NATURE OF RADIATION DAMAGE IN METALS. A. Seeger (Max-Planck-Institut für Metallforschung and Technischen Hochschule, Stuttgart). IAEA Preprint SM-25/41. 43p. (In English)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials held in Venice, Italy, 7-11 May 1962.

The present paper is similar in scope and a sequel to the author's contribution to the Second International Conference on the Peaceful Uses of Atomic Energy. On the whole, the work during the past three years has supported the picture given there for the radiation damage by fast neutrons. (a) The mechanism of the formation of the depleted zones, originally ascribed to the action of dynamic crowdions, has been clarified further by the study of focusing processes by a number of authors. More direct evidence than in 1958 for the existence of the zones has been obtained by electron transmission microscopy (particularly in Harwell) and by ferromagnetic measurements. (b) Considerable work has recently been done on radiation hardening and on the plastic deformation of radiation hardened single crystals. The evidence, including the different effects of electron bombardment, supports the picture that the hardening by fast neutrons is due to the zones, and that these are gradually destroyed during subsequent plastic deformation. (c) In the assignment of migration energies of point defects in noble metals and nickel to the recovery stages observed after electron, heavy charged particle, or neutron bombardment, quenching, or cold-work, particular progress has been made on stage IV (vacancy migration, activation energies: Cu = 1.08 ev, Ag = 0.88 ev, Au = 0.38 ev, Ni = 1.5 ev) and stage III. Stage III is mainly due to the migration of dumb-bell interstitials (migration energies: Cu = 0.61 ev, Ag = 0.58 ev, Au = 0.71 ev, Ni, = 1.05 ev), as could be shown by mechanical and ferromagnetic relaxation experiments. Stage I as observed after electron bombardment is largely due to the recombination of close Frenkel pairs. In Cu, however, the long-range migration of a metastable form of the interstitial appears also to be involved. Presumably this defect, which is not generated by low-temperature cold-work, is the crowdion. In electron-bombarded gold the low-temperature recovery does not show any evidence of this defect. This can be explained in terms of the different interactions of the ion cores in gold and copper, resulting in different focusing and stability conditions. (auth)

22692 RELATIONSHIP BETWEEN COLOUR CENTRES AND DISLOCATIONS IN γ-IRRADIATED POTASSIUM CHLORIDE CRYSTALS. J. Z. Damm (Inst. of Physical Chemistry, Wrocław, Poland). IAEA Preprint SM-25/44. 10p. (In English)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials held in Venice, Italy, 7-11 May 1962.

Optical and hardness measurements were carried out on gamma-induced color centers in KCl and Sr^{2+}-doped KCl crystals. The results show that V centers and new dislocations are formed in undoped KCl but not in Sr^{2+}-doped KCl, presumably because the Sr^{2+} ions lock the primary dislocations. (D.L.C.)

22693 THE RECOVERY OF RADIATION DAMAGE IN MOLYBDENUM. J. Nihoul (Studiecentrum voor Kernenergie, Mol-Donk, Belg.). IAEA Preprint SM-25/47. 15p. (In English)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials held in Venice, Italy, 7-11 May 1962.

An investigation was made of the annealing of defects in neutron-irradiated molybdenum. Molybdenum wires were neutron irradiated at liquid nitrogen temperature and subsequently annealed up to 800°K. The residual resistivity showed two main recovery peaks, one at 130°K and one at 440°K, with associated activation energies of 0.40 ± 0.04 and 1.23 ± 0.06 ev, respectively. The activation energy increases linearly with temperature up to about 350°K where in a rather discontinuous way a 0.25 ev higher value is reached, which remains practically constant up to 480°K. It is proposed that the 1.23 ev stage is basically governed by the same processes as the third annealing stage in the f.c.c. metals. (auth)

22694 IRRADIATION DAMAGE TO BERYLLIUM. G. Summer and E. D. Hyam (United Kingdom Atomic Energy Authority, Springfields, Lancs, and United Kingdom Atomic Energy Authority, Windscale, Cumb., Eng.). IAEA Preprint SM-25/51. 14p. (In English)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials held in Venice, Italy, 7-11 May 1962.

The presence of gas bubbles at grain boundaries modifies the behavior of irradiated materials under stress at elevated temperatures, with marked reduction in ductility and a distinct change in the mechanism of failure. These effects are described in detail for the case of beryllium, with particular emphasis on the microstructural changes observed at grain boundaries. The observations are consistent with the nucleation of grain boundary voids by the gas bubbles and their subsequent growth by vacancy diffusion under intergranular stress. Theoretical considerations indicate that any stress will make a grain boundary bubble grow to some extent but that under a stress greater than a critical value, determined by the initial size of the bubble, the bubble will continue to grow as long as the stress is applied. Further, once the bubble has grown by more than 73% under this stress, the stress required to keep it growing becomes progressively less. (auth)

22695 THE LOW TEMPERATURE IRRADIATION BEHAVIOUR OF CAST URANIUM CARBIDE. B. G. Childs, A. Ogilvie, J. C. Ruckman, J. L. Whitton (Dounreay Experimental Reactor Establishment; Caithness, Scotland). IAEA Preprint SM-25/52. 46p. (In English)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials held in Venice, Italy, 7-11 May 1962.

The electrical resistivity, at 20°C, of cast uranium monocarbide was measured as a function of neutron exposure over the range 0 to 10^{19} n/cm^2. The specimens, which were of natural isotopic content, were irradiated at temperatures estimated to be less than 80°C. The resistivity increased with exposure in an inverse exponential fashion, increases of up to 150% of the original values being observed for previously annealed specimens containing precipitated UC_2. Pure specimens which were free from UC_2, and also UC_2 containing specimens which had been contaminated by tungsten during the melting process, increased rather less in resistivity—typically by 114% after 10^{19} n/cm^2. On subsequently annealing the specimens in a series of increasing temperature steps, between 50 and 70% of the fractional resistivity increment was removed over the interval 20 to 300°C. Virtually complete recovery of the original resistivity values occurred below 800°C. Lattice parameter and microstructural changes were also observed in these specimens. (auth)

22696 THE CRACKING OF IRRADIATED URANIUM. R. G. Bellamy (Atomic Energy Research Establishment, Harwell, Berks, Eng.). IAEA Preprint SM-25/53. 14p. (In English)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials held in Venice, Italy, 7-11 May 1962.

Structural features other than fission product gas bubbles seen in unrestrained, unalloyed uranium irradiated in the alpha range to burn-ups of up to 0.7% of all atoms are described. The main features are: (1) Brittle grain boundary cracks in which the grains appear to have parted without plastic deformation. These cracks are associated with thermal cycling and high maximum temperatures (~600°C). (2) Transgranular cracks, which are comparatively rare. It is suggested that they may be related to the pseudo-cleavage or "twin parting" observed in unirradiated uranium by Cahn. (3) Grain boundary "creep voids" believed to arise from the coalescence of vacancies under tensile stress. The voids may form a path for crack propagation or may themselves coalesce to form cracks. Apart from the direct effects of these features in increasing the volume and changing the thermal conductivity and mechanical properties of the uranium, a mechanism is discussed by which cracks may accumulate fission product gas and cause further volume increases. The possible effects of structural variations in the uranium and of restraint during irradiation on the incidence of cracking and void formation are considered. (auth)

22697 IRRADIATION EFFECTS IN FISSILE OXIDES AND CARBIDES AT LOW AND HIGH BURN-UP LEVELS. B. R. T. Frost, B. T. Bradbury, and L. B. Griffiths (Atomic Energy Research Establishment, Harwell, Berks, Eng.). IAEA Preprint SM-25/54. 23p. (In English)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials held in Venice, Italy, 7-11 May 1962.

Structural changes occurring in UO_2 and in UC during irradiation to burn-ups between 100 and 10,000 Mwd/t were studied by optical and electron microscope techniques. In particular, the change in mode of fracture from transgranular to intergranular and a decrease in bend strength with increasing radiation dose were observed. Radiation damage in UC was studied by measurements of the variation in electrical resistivity with dose on cold irradiated materials, this technique being used subsequently to study the annealing temperatures, the mechanism of annealing, and its kinetics. A series of pellets of UO_2, UO_2-PuO_2 solid solution, UC, and PuC–UC solid solution were irradiated in stainless steel containers to burn-ups in the range 15,000 to 54,000 Mwd/t, the oxide center temperatures being in the range 900 to 1600°C and the carbide center temperatures about 800°C. Post-irradiation examination includes fission-gas analysis, measurement of dimensional changes and a study of structural changes by optical and electron microscopy. (auth)

22698 IRRADIATION DAMAGE IN GRAPHITE. W. N. Reynolds and P. A. Thrower (Atomic Energy Research Establishment, Harwell, Berks, Eng.). IAEA Preprint SM-25/56. 16p. (In English)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials held in Venice, Italy, 7-11 May 1962.

A wide study of defect clusters formed in graphite by high-flux neutron irradiation at temperatures up to 650°C was made, using the techniques of transmission electron microscopy. A linear relationship exists between cluster size and irradiation temperature, and the subsequent annealing behavior of the defects is consistent with the hypothesis that the visible defects are all of one kind, probably interstitial. The difficulty of measuring film thicknesses prevented an accurate comparison of defect behavior with that of macroscopic properties, but there is sufficient evidence to show that other defects than those visible must be involved. Some observations at the highest temperatures and doses suggest that vacancy clusters may also become identifiable. (auth)

22699 SINGLE PHONON ABSORPTION BANDS IN FAST NEUTRON IRRADIATED SILICON. M. Balkanski and W. Nazarewicz (Ecole Normale Supérieure, Paris). IAEA Preprint SM-25/59. 8p. (In English)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials held in Venice, Italy, 7-11 May 1962.

The infrared absorption spectrum in the range 670 to 250 cm^{-1} (15 to 40μ) of silicon bombarded with fast neutrons was studied. The absorption bands at 488, 417, and 332 cm^{-1} are attributed to a single phonon absorption process connected with the excitation of the fundamental modes TO, LO, and LA, respectively. These fundamental modes become active because of the lattice distortion resulting from the produced defects. Thus, the measured phonon energies in silicon are in good agreement with those calculated by Johson on the basis of combination band spectra occurring in silicon perfect single crystals and those obtained by using the method of inelastic scattering of neutrons. (auth)

22700 A STUDY OF NEUTRON IRRADIATION-INDUCED EMBRITTLEMENT OF WELDABLE MANGANESE–MOLYBDENUM STEELS. E. Cibois, J. Lemaire, and M. Weiss (Centre d'Etude Nucléaires, Saclay, France). IAEA Preprint SM-25/70. 55p. (In French)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials held in Venice, Italy, 7-11 May 1962.

The fast-neutron (>1 Mev) embrittlement was studied of a steel of the following composition: C = 0.2; Si = 0.17; S = 0.016; P = 0.018; Mn = 1.32, Sr = 0.09; Ni = 0.05; Mo = 0.47. Irradiation was carried out in each case at a temperature in the neighborhood of 180°C, and differs from the work normally reported in the literature in that it was done with a weak instantaneous flux of 1 to 2×10^{11} nv. The fast integrated flux was estimated to be about 5×10^{18} nvt. The intermediate flux (epithermal) was estimated to be 10 times greater, but was not measured exactly. The following factors were investigated: (1) position of sample in a thick sheet (110 mm). 4 cases were considered: skin, core, lengthwise, and crosswise. (2) effect of previous work hardening (at ambient temperature). (3) influence of heat hardening and tempering. (4) influence of superheating (grain size). It was found that the increase Δt in the transition temperature and the increase in impact resistance are comparable to, but slightly larger than, those indicated recently in the literature. For similar compositions it was found that Δt_2 was of the order of about 80°C in the normal and tempered state. The position from which the sample is taken in the sheet has little influence. Work hardening followed by natural aging likewise appears to have little effect on Δt. Moreover, in the cases of hardening and tempering embrittlement appears to be considerably diminished (Δt approximately 50°C). The corresponding hardening, as measured from the raising of the elastic limit, is still considerable up to 400°C. No distinct correlation could be observed between this hardening and the increase Δt. Irradiation appears to modify the processes associated with the blue brittleness of the steel studied. (auth)

22701 THE EFFECTS OF IRRADIATION ON THE MECHANICAL PROPERTIES OF ZIRCALOY-2. J. L. Bernard, E. Cibois, J. Lemaire, and M. Weiss (Centre

d'Etudes Nucléaires, Saclay, France). IAEA Preprint SM-25/71. 43p. (In French)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials held in Venice, Italy, 7-11 May 1962.

The effects of low-temperature irradiation (below 100°C) on the mechanical properties of Zircaloy-2 were studied. Two irradiation levels were employed: 1. Fast flux (>1 Mev) = 5×10^{17} nvt; thermal flux = 2×10^{20} nvt. 2. Fast flux (>1 Mev) = 1×10^{18} nvt; thermal flux = 8×10^{20} nvt. The material studied was in four different states: extruded, extruded-annealed; extruded and drawn; and extruded, drawn, and annealed. In each case ten tensile test bars and ten impact resistance test bars (Charpy V) were irradiated. The control specimens corresponding to each case were tested under the same conditions. Besides the normal effects, i.e., a marked raising of the elastic limit and breaking load and a decrease in elongation, the following peculiarities were observed: 1. Except in the case of work-hardened metal, for which the impact resistance at temperatures below 100°C retains its rather low value, the effect of irradiation is to increase the breaking energy by an amount depending on the nature of the metal. 2. The tensile test results indicate two distinct cases: (a) In the raw extruded or in the extruded-annealed state, irradiation considerably modifies the shape of the low-temperature tensile test curves (<100°C) in the α-zone and leads to the appearance of a kink at the elastic limit followed by a long plateau. Irradiation hardening is particularly noticeable at the beginning of the consolidation curve, but has little effect in the case of large elongations. This is in conformity with the theoretical description by Friedel. Nevertheless, it was noted that the "hardening due to irradiation," i.e., the raising of the elastic limit, was very much dependent on temperature. (b) For recrystallized metal after drawing, initial consolidation in the neighborhood of the elastic limit is particularly accentuated by irradiation and the hardening is little affected by temperature. A relative brittleness at about 100°C was also observed in the irradiated metal. A study of recovery after annealing gives results which are in good agreement with the literature. The case of drawn metal presents certain peculiarities which are discussed. (auth)

22702 ANALOGIES BETWEEN THE RADIATION EFFECTS ON SOLIDS CAUSED BY NUCLEAR RADIATION AND FLUXES OF SLOW CHARGED PARTICLES IN SOLIDS. S. V. Starodubtsev. IAEA Preprint SM-25/75. 13p. (In Russian)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials held in Venice, Italy, 7-11 May 1962.

Hitherto, few contacts have been made between conventional electronics and radiation physics although, for a large body of phenomena, the nature of interactions between fluxes of particles and matter is practically identical, and the classical methods of cathode electronics can be successfully applied to the investigation of a complex group of effects in radiation physics, including the stability of reactor materials. The action of ionizing radiation on a solid can generally be divided into a first and second stage. In the first stage, a comparatively small number of initiating particles resulting from the ionization of atoms (photo effect, Compton effect for gamma rays, ionizations of atoms for beta particles, ionizations and nuclear collisions for alpha particles and other heavy particles) produce a small number of fast electrons and recoil nuclei. In the second stage, these charged particles distribute their energy among a large number of secondary recoil electrons and atoms. Hence, radiation disturbances in solids are caused almost entirely by recoil electrons or atoms having an energy of the order of 100 ev for any primary particle energy. Thus, if a large number of electrons or ions can be obtained directly with the comparatively small velocities (energies) of 10^2 to 10^5 ev, then the same effect can be obtained as with ionizing radiation. The main difference will be that the radiation effects in the case of nuclear radiation will extend to greater thicknesses of a substance. Accordingly, a study of phenomena occurring on and near the surface indicates that the effect in both cases will be qualitatively identical and, if the dose measurement is correct, quantitatively as well; more particularly, similar changes must be expected in the case of the action of ionizing radiation and gas discharges on thin films and gels. (a) It was established that the hydrogen ion bombardment, say, of quartz and lithium fluoride gives rise in a thin layer to practically the same radiation damage as irradiation with gamma quanta and neutrons; (b) It is shown that the absorptive properties of vacuum-annealed silica gel are appreciably improved under the action of reactor radiation; similarly, if silica gel in a rarefied gas is exposed to a high-frequency discharge, there is a considerable increase in the adsorption of the gel; (c) The bombardment of reactor materials with accelerated ions in tubes affords an opportunity to predetermine their behavior in reactors. (auth)

22703 RECOVERY OF γ-RADIATION DAMAGE IN p-TYPE INDIUM ANTIMONIDE. K. D. Alexopoulos and R. B. Oswald, Jr. (Univ. of Athens). IAEA Preprint SM-25/77. 7p. (In English)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials held in Venice, Italy, 7-11 May 1962.

A p-type InSb crystal was irradiated with Co γ-rays at liquid nitrogen temperature and then isochronally tempered at consecutively higher temperatures. Before irradiation and after each step, the Hall coefficient and the resistivity were measured at liquid nitrogen temperature. The radiation damage consisted in an increase of the positive holes while the Hall mobility remained unchanged within experimental error. From the isochronal tempering experiments, three groups of annealing processes were observed at the temperature of (a) 83 to 100, (b) 160 and (c) 295°K. These temperature ranges are the same as observed by Aukerman for damage by 4.5 Mev electrons. The displacement rates for the production of each type of damage were found to be equal to (a) 5.9, (b) 0.143 and (c) 0.191 in 10^3 positive holes per cm^3/photons per cm^2. Their sum, the total displacement rate, is somewhat smaller than the value found by Whitsett. (auth)

22704 RELAXATION OF ELASTIC STRESSES IN IRRADIATED MATERIALS. P. A. Platonov. IAEA Preprint SM-25/85. 19p. (In Russian)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials held in Venice, Italy, 7-11 May 1962.

Investigations were made on the effects of radiation on relaxation of the elastic stresses in bent plates under neutron bombardment. Trials were made with the following materials: nickel, ferromolybdenum, tungsten, stainless steel, Nichrome, low-alloy carbon steel, chrome–molybdenum–vanadium spring steel and graphite. It was found that at 120 to 140°C, neutron bombardment produces a marked relaxation of stresses in all the materials, and that, among the metals, it is in nickel that the relaxation effect is strongest. Comparison of relaxation with hardening of the materials shows that the degree of relaxation probably depends on that of hardening. Nickel, for instance,

showing the greatest change in its yield point, undergoes very marked relaxation. Under the effects of irradiation, the temporal characteristics of relaxation differ from those of the normal curve; under normal conditions, relaxation is more intense during the first hours, whereas under irradiation it is spread much more evenly, probably due to a progressive accumulation of defects. No relationship was discerned between relaxation and stress; there was identical lowering of stress in stainless steels with initial stresses of 30 and 18 kg/mm^2. The relaxation tests with nickel and tungsten were carried out in the temperature range 150 to 350°C and did not reveal any appreciable interdependence between relaxation and temperature. The main characteristic of irradiation-induced relaxation is its reversibility, which is due to the fact that in metals irradiated under stress an appreciable late effect is observed, which in certain cases may amount to 70% of the total effect. In the course of investigating the late effect in nickel, tungsten, molybdenum and graphite, two stages were distinguished. It was supposed that the low-temperature part of the late effect is conditioned by the migration of point defects, while the stage occurring at high temperatures is governed by cluster defect damage. This hypothesis is confirmed by measurement of the activation energy of the late effect. In the case of tungsten and graphite, a clear relationship was found between the nature of the late effect and the radiation dose. Increase of the dose leads to a reduction of the low-temperature part of the late effect, which is probably due to a merging of point defects and the formation of stable clusters. A similar effect is connected with temperature, as was shown for tungsten and nickel. (auth)

22705 THE EFFECTS OF NEUTRON BOMBARDMENT ON THE ORDERED ALLOY Fe_3Al. G. P. Saenko. IAEA Preprint SM-25/86. 22p. (In Russian)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials held in Venice, Italy, 7-11 May 1962.

Investigation was made of the effect on an iron–aluminum alloy, with a composition close to Fe_3Al, of various integral doses of neutron radiation lying between 3×10^{18} and 1.35×10^{20} n/cm^2 at a temperature of about 80°C. For the purpose of these experiments, an ordered and a disordered alloy were prepared. The first was obtained by prolonged annealing and the second by two different processes: (a) high temperature hardening and (b) cold deformation. It was shown that although there is no long-order chain in the hardened alloy, it nevertheless does not constitute a disordered solid solution in the statistical sense. Measurement of certain properties has led to the belief that the effect of hardening is to create a short-order chain in the alloy. A study was made of the radiation-induced changes occurring in the following characteristics of the alloy: specific electrical resistance, temperature coefficient of electrical resistance, magnetic moment, crystal lattice spacing and thickness of the superstructural lines. After bombardment with doses of 7×10^{19} and 1.35×10^{20} n/cm^2, the alloy was annealed in order to ascertain the electrical resistance and lattice spacing in relation to temperature and time. The investigation showed that radiation progressively destroys the long-order chain in a previously annealed alloy. At the same time, the superstructural lines disappear from the radiograph, and the electrical resistance, magnetic moment, and lattice spacing increase. The same disordering effect of irradiation is apparent in a previously hardened alloy in that it manifests an increase in lattice spacing and magnetic moment after exposure in the reactor. The hypothesis of neutron destruction of the short order of a hardened alloy is confirmed by the observed decrease in its electrical resistance. A previously deformed alloy manifests a less regular change in its properties, as a function of radiation dose, than annealed and hardened alloys. In spite of the complexity of the relationship, a deformed alloy submitted to various radiation fluxes shows increased electrical resistance and decreased lattice spacing and magnetic moment. These changes show that neutron bombardment tends to produce order in the alloy. Annealing shows that, whereas after maximum irradiation (1.38×10^{20} n/cm^2) the resistance and lattice spacing of annealed and hardened alloys are more or less the same, their physical state is completely different. This is closely linked with the initial structure of the alloy. It was possible to distinguish two annealing stages for the disturbances due to radiation and to determine the activation energy (33,000 cal/mole) corresponding to the low temperature stage. A discussion is given of the various mechanisms of radiation-induced disorder in previously ordered alloys, in particular, the role of "displacement spikes." (auth)

22706 EFFECTS OF NEUTRON BOMBARDMENT ON THE ELECTRICAL RESISTANCE OF CERTAIN METALS. A. N. Ivanov and N. F. Pravdyuk. IAEA Preprint SM-25/87. 38p. (In Russian)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials held in Venice, Italy, 7-11 May 1962.

Data are given on the effects of neutron bombardment on the specific electrical resistance of certain transition metals (iron, nickel, zirconium, titanium, molybdenum, and tungsten). Irradiation was carried out at temperatures of 40 to 50°C in an empty channel of the RFT reactor core. In the cases of iron, nickel, and zirconium, irradiated in both the annealed and cold-deformed states, previously deformed samples (rolling to 90%–95% shrinkage) show lower relative and absolute growths in specific electrical resistance after irradiation. Tungsten and molybdenum show a relative change in specific resistance several times higher than in the case of the other metals examined. The possibility is discussed of using them as a measure of radiation disturbance and to determine the real temperature of irradiation (in cases where a thermocouple cannot be used). Measurement of the electrical resistance of molybdenum during irradiation at integral fast neutron doses of 2×10^{19}/cm^2 (E = 1 Mev) showed that the rise in specific resistance is a function of the integral dose and that, for a given dose, it is practically independent of the temperature range in which measurements are made (20 to 135°C), i.e. it follows Matthiessen's rule. Diagrams are presented showing the changes in the electrical resistance of tungsten, zirconium, and platinum as a function of the integral neutron dose, the data being obtained by direct measurement during irradiation of the metals at the working temperature of the reactor. Information is given on the isochronal annealing of radiation disturbance in the metals examined. The removal of radiation disturbance, in the cases of iron and titanium irradiated in the annealed state, and of zirconium irradiated in both the annealed and cold-deformed states, proceeds in a single stage and ends at temperatures between 250 and 450°C. A similar situation is found when deformed zirconium is annealed. Repair of disturbances in iron irradiated in the deformed state and in non-irradiated deformed iron proceeds in two stages, and in all cases elimination of the growth in specific resistance is completed at temperatures of about 550°C. When deformed iron is irradiated, the absolute increase in specific electrical resistance, which disappears at temperatures above 400°C (second annealing stage) diminishes as the in-

tegral dose rises, while the absolute component of the increase grows when annealing is carried out at temperatures below 400°C (first annealing stage), with the temperature range of this stage being extended upwards. The nature of the annealing curves for the growth of specific resistance shows a tendency for complete disappearance of the second stage of annealing when the integral neutron dose is sufficiently large. Removal of radiation disturbance in the case of tungsten and molybdenum irradiated in the annealed state takes place in two stages, respectively at 100 to 400°C and and 400 to 1000°C for tungsten and 100 to 250°C and above 450°C for molybdenum. In the case of tungsten, the second stage of annealing is slow and after isochronal annealing up to 1000°C, 2 to 20% (depending on the integral dose) of the increase in specific electrical resistance remains. Experiments in which molybdenum and tungsten were subjected to isochronal annealing showed that the relative component of the total increase in specific resistance, which disappears during the first stage of annealing, decreases as the integral dose grows. This is probably explained by the formation of more "thermally resistant" defects as the dose increases. (auth)

PHYSICS

General and Miscellaneous

22707 (AD-269887) HIGH TEMPERATURE THERMOELECTRIC GENERATOR. First Quarterly Progress Report, October 1, 1961–December 29, 1961. C. M. Henderson and R. G. Ault (Monsanto Research Corp. Dayton Labs., Ohio). Contract AF33(657)-7387. 29p. (MRC-2509)

Applied research and development is reported on a laboratory thermoelectric generator operating at a hot junction temperature of 1200°C and a cold junction of 500 to 700°C in a vacuum of 1/100,000 mm Hg. Apparatus needed to fabricate and test candidate junction materials and modules for use with a new proprietary thermoelectric material, MCC 50, are described. Tests to be conducted include mechanical strength, sublimation loss, electrical properties, thermal shock, and resistance to solid-state diffusion. Preliminary efforts to produce modules of MCC 50 in combination with tantalum, titanium, molybdenum, and tungsten by hot press, resistance welding, and brazing were only partially successful. However, a graphite-MCC 50-graphite module was produced which exhibited junctions of promising mechanical strength and preliminary measurements of its electrical properties were made. (auth)

22708 (AD-269951) BIBLIOGRAPHY ON RECENT ADVANCES IN APPLIED ELECTRO PHYSICS. LTIS Bibliography No. 11. John B. Forlini (Army Engineer Research and Development Labs., Fort Belvoir, Va.). Nov. 1961. 42p.

Ninty-one references on developments in applied electro physics are given to reports and U. S. and foreign literature published from 1943 to 1961. The references are listed alphabetically by title. (P.C.H.)

22709 (AD-271032) KINETIC THEORY OF RAREFIED GASES AND OF HIGHLY HEATED DIATOMIC GASES. Final Technical Report. Part II, October 1, 1960 to September 30, 1961. (Berlin. Freie Universitat). Contract DA-91-591-EUC-1592. 119p.

The stationary flow of a monatomic gas around a sphere is considered. For solving Boltzmann-equation in this case, a special iteration-process is introduced. The zeroth step is constructed with the help of a special Ansatz. The Ansatz allows the fulfilling of the demanded boundary-conditions and leads with the help of Maxwell's transport-equations for a special molecule-model to a system of six nonlinear partial differential-equations. These equations are not yet solved. Hydrodynamic equations for polyatomic gases using an extended Grad method are derived. The results are equations which can be simplified to equations corresponding to the Navier-Stokes equations for monatomic gases. Some numerical results about the development of the flow of a dissociating gas past a shock front are given. (auth)

22710 (AFSWC-TDR-62-12(Vol.II)) THEORETICAL STUDY OF HYDROMAGNETIC STABILITY AND TURBULENCE. INVESTIGATIONS AND DETAILED RESULTS. Annual Report, Period: January 1–December 31, 1961. John Jarem, et al. (Radio Corp. of America. Missile and Surface Radar Div., Moorestown, N. J.). Contract AF29(601)-4142. 810p.

The annual technical report on the theoretical study of hydromagnetic stability and turbulence describes fourteen investigations of the smooth and perturbed motion of bomb debris plasma expanding into an ionized atmosphere and magnetic field background. (auth)

22711 (AFSWC-TDR-62-12(Vol.II)(Chap.1)) SNOWPLOW AND MULTIPLE BOUNCE MODELS FOR THE EXPANSION AND RETARDATION OF A PLASMA EXPLOSION BUBBLE. M. D. Kruskal, I. B. Bernstein, and R. M. Kulsrud (Radio Corp. of America. Missile and Surface Radar Div., Moorestown, N. J.). Chap. 1 of THEORETICAL STUDY OF HYDROMAGNETIC STABILITY AND TURBULENCE. INVESTIGATIONS AND DETAILED RESULTS. Annual Report, Period: January 1–December 31, 1961. 25p.

Two models describing the expansion of a plasma bubble into an ambient ionized atmosphere are studied. The plasma bubble is a cold perfectly conducting medium which expands uniformly from zero radius. The external environment is assumed to decelerate the expansion by exerting constant back pressure at the interface separating the freely expanding medium from its surrounding. The snowplow model assumes that any element of uniformly expanding plasma which strikes the interface adheres to the interface. The multiple bounce model assumes that any element of the freely expanding plasma which strikes the interface is specularly reflecting therefrom. Since the interface is decelerating, a given element of fluid collides again and again as the interface catches up with it. The multiple bounce picture leads to the formation of a surface layer containing particles which are reflected at least once by the interface. The simpler snowplow model is a good approximation to the multiple bounce model so long as the thickness of this surface layer is small compared with the retardation of the interface from the position it would have if the expansion were an ideal free expansion. The multiple bounce model is plausible as long as this surface layer thickness is much greater than the distance of penetration of the magnetic field predicted by microscopic theory. Both models are reasonable representations of the independent expansion in the early expansion period and at altitudes where the effect of neutrals can be neglected. (auth)

22712 (AFSWC-TDR-62-12(Vol.II)(Chap.2)) THE UNIFORM EXPANSION OF A SPHERICAL PLASMA BUBBLE INTO AN IONIZED ATMOSPHERE IN A WEAK MAGNETIC FIELD. I. B. Bernstein, J. B. Fanucci, M. D. Kruskal, R. M. Kulsrud, and N. Ness (Radio Corp. of America. Missile and Surface Radar Div., Moorestown, N. J.). Chap. 2 of THEORETICAL STUDY OF HYDROMAGNETIC STABILITY AND TURBULENCE. INVESTIGATIONS AND DETAILED RESULTS. Annual Report, Period: January 1–December 31, 1961. 54p.

The expansion of a perfectly conducting spherical piston expanding at constant radial speed into an ideal hydromagnetic fluid is investigated. The ideal hydromagnetic fluid is characterized by constant density pressure and magnetic field. The piston starts from a point and drives a nonspherical shock ahead of itself in the ideal hydromagnetic field. The condition of the fluid in the undisturbed region ahead of the shock is related to that behind the shock by the appropriate magnetohydrodynamic shock relations. The situation possesses azimuthal symmetry about an axis through the center of the piston and parallel to the constant external magnetic field. The structure of the ideal hydromagnetic equations admits of a similarity solution appropriate to this expansion. That is, by introducing a new vari-

able, namely the position vector divided by the time. It is possible to transform the actual time dependent problem into a static flow in terms of the new variable. The resultant equations are solved in the limit where the magnetic pressure in the surrounding medium is much less than the material pressure. This permits an expansion essentially in powers of the ratio of Alfven speed to sound speed. The expansion procedure leads to equations which decompose such that the perturbation nonmagnetic quantities involve only odd powers of the parameter of smallness and all other quantities involve only even powers. To lowest order one has the Taylor solution to the hydrodynamic spherical expansion. The lowest significant order magnetic field and perturbations in pressure density and velocity can then be computed. The most interesting result of this calculation is the prediction of the occurrence of a boundary layer near the piston. In this boundary layer the magnetic field which everywhere else is small rises to a value such that the magnetic pressure is comparable with the material pressure. This conclusion is independent of the magnitude of the magnetic field. (auth)

22713 (AFSWC-TDR-62-12(Vol.II)(Chap.3)) THE UNIFORM EXPANSION OF A SPHERICAL PLASMA BUBBLE INTO AN IONIZED ATMOSPHERE IN A STRONG MAGNETIC FIELD. I. B. Bernstein and R. M. Kulsrud (Radio Corp. of America. Missile and Surface Radar Div., Moorestown, N. J.). Chap. 3 of THEORETICAL STUDY OF HYDROMAGNETIC STABILITY AND TURBULENCE. INVESTIGATIONS AND DETAILED RESULTS. Annual Report, Period: January 1–December 31, 1961. 29p.

The uniform expansion of a perfectly conducting spherical bubble into an ideal hydromagnetic fluid of constant density, uniform field, and zero pressure is considered. It is supposed that the Alfven speed associated with the density and magnetic field is much greater than the expansion speed. In this circumstance a weak spherical shock propagates at the Alfven speed into the undisturbed region. At any instant the region behind the shock is very large compared with the volume of the piston. Over most of this region the magnetic field is perturbed very little from its equilibrium value and the linearized theory is appropriate. Close to the piston the magnetic field is perturbed a finite amount which to the lowest order is given by the vacuum dipole field associated with a perfectly conducting sphere in a constant external magnetic field. The linearization procedure permits the explicit solution for all quantities, the magnetic field, pressure, density, and velocity in terms of elementary functions. It is found to lowest significant order that all quantities are continuous across the shock surface. There remains in this limit to solve a boundary layer problem in the vicinity of the piston so as to determine more precisely the nature of the fields and the flows. (auth)

22714 (AFSWC-TDR-62-12(Vol.II)(Chap.4)) THE NON-UNIFORM EXPANSION OF A CYLINDRICAL OR SPHERICAL PLASMA INTO AN IONIZED ATMOSPHERE IN A WEAK MAGNETIC FIELD. N. Ness, J. B. Fanucci, and L. J. Kijewski (Radio Corp. of America. Missile and Surface Radar Div., Moorestown, N. J.). Chap. 4 of THEORETICAL STUDY OF HYDROMAGNETIC STABILITY AND TURBULENCE. INVESTIGATIONS AND DETAILED RESULTS. Annual Report, Period: January 1–December 31, 1961. 90p.

A solution is obtained for the non-uniform expansion of a plasma bubble into a weak uniform external hydromagnetic medium containing a small magnetic field. A perturbed method is employed wherein the effects of the magnetic field and piston deceleration are considered to be small perturbations about the hydrodynamic solution of Taylor. The solution presented considers these effects to first order. It is shown that the shock shape remains spherical and that deviations from sphericity are introduced, initially, only to second order in the parameter of smallness where a coupling between the magnetic field and the bubble deceleration exists. Calculations are performed for both accelerating and decelerating bubbles. In both cases it is shown that the time rate of change of the shock for a given specific heat ratio and ambient sound speed is negligible. That is, for small times the shock propagates at practically uniform speed independent of bubble deceleration. The analysis is related to the snowplow solution. The velocities and positions of the bubble and shock are determined. (auth)

22715 (AFSWC-TDR-62-12(Vol.II)(Chap.5)) THE ARBITRARY EXPANSION OF A FREELY STREAMING PLASMA BUBBLE INTO EITHER VACUUM MAGNETIC FIELD OR AN IONIZED ATMOSPHERE: SMOOTH FLOWS AND THE FORMULATION OF THE GENERAL STABILITY PROBLEM. I. B. Bernstein and R. M. Kulsrud (Radio Corp. of America. Missile and Surface Radar Div., Moorestown, N. J.). Chap. 5 of THEORETICAL STUDY OF HYDROMAGNETIC STABILITY AND TURBULENCE. INVESTIGATIONS AND DETAILED RESULTS. Annual Report, Period: January 1–December 31, 1961. 34p.

The general formulation of the free expansion of a perfectly conducting fluid either into an ideal hydromagnetic fluid or into a vacuum magnetic field is presented. The kinematics and dynamics of the snowplow model for an arbitrary interface between the freely expanding matter and the external medium are presented. The problem of the stability of the snowplow model against small perturbations is then formulated. The theory is presented in terms of the Lagrangian displacement of an element of surface from its unperturbed location. Linear equations of motion for the surface mass density and displacement vector are found. For the spherical case of an unperturbed spherical motion against a constant pressure the linear equations are reduced by the introduction of vector spherical harmonics. The stability of the motion against small perturbations when the ambient medium is an ideal hydromagnetic fluid is then formulated in terms of the Lagrangian displacement of an element of fluid from its unperturbed motion. The coefficients in this equation involve the perturbed shock conditions by integrals along unperturbed trajectories of the element of fluid. This formulation for the natural extension of the method is employed for analyzing the stability of magnetohydrostatic equilibria when there is no shock or mass velocity in the unperturbed state. Lastly, these equations are examined with the limiting situation of a spherical motion into a medium containing no magnetic field and characterized by constant pressure and density. The next case investigated is one wherein the ambient medium is assumed to be a vacuum magnetic field. The associated potential problem in an infinite domain exterior to a topological sphere is transformed by inversion into an equivalent problem in the interior or topological sphere. The axisymmetric case is treated in the same fashion by a magnetic stream function which has a simpler boundary condition. The snowplow equations governing the interface between the freely expanding plasma and the vacuum magnetic field are given in Eulerian form for the axisymmetric case. One can then introduce convenient dimensionless variables such that for the expansion into a constant magnetic field it is necessary to solve the problem only once; all other solutions can then be obtained by scaling. (auth)

22716 (AFSWC-TDR-62-12(Vol.II)(Chap.6)) SOME USEFUL MAGNETOHYDRODYNAMIC SHOCK RELATIONS. M. Kruskal, I. B. Bernstein, and R. M. Kulsrud (Radio Corp. of America. Missile and Surface Radar Div., Moorestown, N. J.). Chap. 6 of THEORETICAL STUDY OF HYDROMAGNETIC STABILITY AND TURBULENCE. INVESTIGATIONS AND DETAILED RESULTS. Annual Report, Period: January 1–December 31, 1961. 10p.

Shock relations are derived for an ideal hydromagnetic nonviscous fluid satisfying an adiabatic equation of state and interacting with an electromagnetic field. The shock conditions are obtained by casting the governing hydromagnetic equation into the form of Galilean invariant conservation laws valid in the non-relativistic limit. The shock is thought of as a thin layer across which the variables change rapidly but continuously. A proper derivation of shock relations is not based on the assumption of validity of fluid equations in the shock layer, but on the assumption that general conservation laws hold in the region. Integration of these conservation laws which occur in a divergence form across the shock layer yields the magnetohydrodynamic shock conditions. These express continuity across the interface of magnetic flux, mass, momentum, and energy. The system of boundary conditions thus generated is shown to be independent of the component of the shock velocity tangent to the shock surface; hence, this component can be chosen for convenience in any calculation. These relations serve to completely determine the situation on one side of the shock in terms of conditions on the other. It is particularly convenient to present the results parametrically in terms of the shock strength in which case the solution of the shock conditions for the density, pressure, velocity, and magnetic field on one side can be obtained in terms of the density, velocity, and magnetic field on the other side and the shock strength. (auth)

22717 (AFSWC-TDR-62-12(Vol.II)(Chap.7)) EQUILIBRIUM MICRO-STRUCTURE OF A COLLISIONLESS PLASMA SHEATH. T. W. Johnston (Radio Corp. of America. Missile and Surface Radar Div., Moorestown, N. J.). Chap. 7 of THEORETICAL STUDY OF HYDROMAGNETIC STABILITY AND TURBULENCE. INVESTIGATIONS AND DETAILED RESULTS. Annual Report, Period: January 1–December 31, 1961. 84p.

The technique of generating self-consistent solutions of the collisionless Boltzmann and Maxwell equations for the steady state of a plasma in an electromagnetic field is studied. The method is useful in practice only for situations which possess a high degree of symmetry in which circumstance the distribution function can be retained in terms of certain particle constants of the motion. It includes the case where thermal motions are large. A limited case of particular interest is that of Rosenbluth and Garwin. It provides information on the micro-structure of the interface which was treated by the multiple bounce model. Cold ions and electrons of the same velocity are assumed to impinge normally on a constant external magnetic field which serves to reflect them. The problem is one dimensional in the normal distance from the plane on which the electron density terminates. Near this plane the plasma departs from charge neutrality. Also, the magnetic field penetrates the plasma to some extent. More general equilibria are discussed and recommendations are made for certain simplifying approximations which conceivably might lead to situations more amenable to calculation. (auth)

22718 (AFSWC-TDR-62-12(Vol.II)(Chap.8)) TAYLOR INSTABILITY OF A DEBRIS INTERFACE UNDER VARIABLE ACCELERATION. J. Jarem (Radio Corp. of America. Missile and Surface Radar Div., Moorestown, N. J.). Chap. 8 of THEORETICAL STUDY OF HYDROMAGNETIC STABILITY AND TURBULENCE. INVESTIGATIONS AND DETAILED RESULTS. Annual Report, Period: January 1–December 31, 1961. 197p.

The Taylor instability of the interface separating an expanding plasma from the hydromagnetic region is studied. The plasma is treated as incompressible and the bubble interface which is assumed to be under variable acceleration is treated as a surface of discontinuity. The motion of the surface of discontinuity is prescribed and the flows determined so as to be compatible. The fluids on either side of the interface are viewed as being ideal hydromagnetic fluids and the boundary conditions appropriate to a moving interface are satisfied. The problem of small motions about such time dependent flows is considered by means of linearization and applied to planar, cylindrical and spherical interfaces. In choosing the appropriate simple flows, the stability problem is reduced to examination of a linear second order differential equation whose time dependent coefficients are functions of the equilibrium. For planar interfaces the stability equation is derived for hydrodynamic and hydromagnetic fluids and solved for a variety of time dependent polynomial and sinusoidal interface accelerations. For a sinusoidal acceleration the problem is reduced to a Mathieu equation whose stability regions are well known. The stability of a cylindrical interface is studied for the case of an infinitely long cylinder. A plasma line source along the axis drives the interface radially against an external axial field with a prescribed time-dependent acceleration. The stability equation for this case is a second order differential equation in which the time-dependent factors are given by ratios of Bessel functions of imaginary argument. The equation was integrated numerically for expanding and contracting cylinders illustrating stable and unstable perturbations. Limiting cases for large and small cylinder radius were also considered. For the spherical bubble expanding into an ionized atmosphere, the interface stability equation was derived and discussed in the WKB limit. Stability was shown to depend on the polar wave number, bubble density, external density, bubble radius, and surface velocity and acceleration. In the case of expansion against a uniform vacuum field, it was shown that the bubble grows initially like a prolate spheroid at a rate which is proportional to the square of the magnetic field. (auth)

22719 (AFSWC-TDR-62-12(Vol.II)(Chap.9)) STABILITY OF A CYLINDRICAL DEBRIS INTERFACE UNDER OSCILLATORY MOTION. J. Jarem (Radio Corp. of America. Missile and Surface Radar Div., Moorestown, N. J.). Chap. 9 of THEORETICAL STUDY OF HYDROMAGNETIC STABILITY AND TURBULENCE. INVESTIGATIONS AND DETAILED RESULTS. Annual Report, Period: January 1–December 31, 1961. 14p.

The Taylor instability of an infinitely long cylinder pulsating radially against a uniform axial field is investigated. This model represents the bubble prolate shape in the late expansion period where it is assumed that the debris plasma is an incompressible ideal hydromagnetic fluid. The prescribed radial oscillations of the cylinder are achieved mathematically by a suitable variation of a line source located along the axis. The stability equation is of a Hill type with time-dependent coefficients which are given by Bessel functions of imaginary argument. Certain limiting forms of this equation are considered and the stability of the general case is studied using Floquet theory. Regions of stability are computed and found to depend on perturba-

tion wave numbers, bubble oscillatory amplitude, frequency and mean radius. For the range of parameters investigated, wide regions of instability are found indicating probable break-up of the oscillating cylinder. (auth)

22720 (AFSWC-TDR-62-12(Vol.II)(Chap.10)) STABILITY OF THE SNOWPLOW DIFFERENTIAL EQUATION REPRESENTING THE EXPANSION OF A PLASMA BUBBLE. M. D. Kruskal and W. F. Trench (Radio Corp. of America. Missile and Surface Radar Div., Moorestown, N. J.). Chap. 10 of THEORETICAL STUDY OF HYDROMAGNETIC STABILITY AND TURBULENCE. INVESTIGATIONS AND DETAILED RESULTS. Annual Report, Period: January 1–December 31, 1961. 20p.

A good approximation to the expansion of a radial bubble against constant external pressure is provided by the snowplow model. According to this model, it is assumed that as the free expanding debris strikes the decelerated interface it sticks to it and contributes to the sheath mass. This model leads to a second order non-linear differential equation with the radius of the bubble as a function of time which must be solved subject to the initial conditions that at zero time the radius is zero and the radial velocity equal to that of the free expanding matter. The uniqueness of solutions of the above-mentioned non-linear ordinary differential equation, the location and nature of the singular points, and the stability of the solution are analyzed. The results of the analysis are that the solution decreases to zero in time with no singularity along the way and that the differential equation is stable. The snowplow model is probably stable against perturbations whose scale length is comparable with the instantaneous bubble radius. (auth)

22721 (AFSWC-TDR-62-12(Vol.II)(Chap.11)) THE STABILITY OF PLANAR HYDRODYNAMIC SHOCK WAVES—A PILOT INVESTIGATION FOR THE MAGNETOHYDRODYNAMIC SHOCK STABILITY PROBLEM. M. Kruskal (Radio Corp. of America. Missile and Surface Radar Div., Moorestown, N. J.). Chap. 11 of THEORETICAL STUDY OF HYDROMAGNETIC STABILITY AND TURBULENCE. INVESTIGATIONS AND DETAILED RESULTS. Annual Report, Period: January 1–December 31, 1961. 18p.

The stability of a planar hydrodynamic shock is investigated. The fluid on each side of the shock is taken to be an ideal fluid satisfying the adiabatic equation of state with a ratio of specific heats greater than unity. The standard non-relativistic shock conditions are used. In the unperturbed fluid state a frame of reference moving with the shock velocity is chosen. This can be accomplished because the system is Galilean invariant. The unperturbed flows are taken to be space and time independent so that the stability problem can be developed by means of a Fourier analysis. By applying first-order perturbation theory to the linearized shock and fluid equations, a dispersion relation or consistency condition is derived which shows the plane hydrodynamic shock to be stable. The stability of planar shocks is not only the simplest and the most representative case which could be considered but is of direct significance for shocks of arbitrary geometry. Therefore, knowledge of the stability of planar shocks is useful in the analysis of shocks induced by an expanding bubble. This application of planar shock theory is valid because shocks respond in a purely local fashion to perturbations of wavelength small compared with the local radius of curvature and locally all shocks look planar. It is also noteworthy that a planar shock wave treated as a discontinuity has no characteristic length associated with it. Therefore, if planar shocks are found to be unstable, it will follow that those of any shape are also unstable at least with reference to small wavelength perturbations. (auth)

22722 (AFSWC-TDR-62-12(Vol.II)(Chap.12)) UNSTABLE MODES IN A HOMOGENEOUS REFLECTING PLASMA SHEATH. I. P. Shkarofsky (Radio Corp. of America. Missile and Surface Radar Div., Moorestown, N. J.). Chap. 12 of THEORETICAL STUDY OF HYDROMAGNETIC STABILITY AND TURBULENCE. INVESTIGATIONS AND DETAILED RESULTS. Annual Report, Period: January 1–December 31, 1961. 47p.

As a pilot problem for the difficult case of the stability of the Rosenbluth-Garwin sheath, the simpler situation wherein charged particles are reflected by an infinite planar boundary is examined. The electrons in their unperturbed state drift with a constant velocity toward the boundary and are reflected in a plane, the motion being two dimensional. Ions travel only along the normal toward and away from the boundary. The dispersion relation for the perturbed state is investigated neglecting ion oscillations. The relation is investigated for electrons streaming only perpendicular to the boundary, but the propagation vector has arbitrary direction. The streaming direction is then relaxed but the direction of propagation vector is then consecutively limited to be in various planes. A general analysis for the growing waves including ion effects is presented. The conditions which lead to instabilities are derived. Consideration is given to a different class of waves which increase exponentially in space towards the surface. It is plausible that this model should approximate the more refined model for perturbations whose wavelengths are large compared with the length characteristic of the sheaths in the Rosenbluth-Garwin model. (auth)

22723 (AFSWC-TDR-62-12(Vol.II)(Chap.13)) CONDUCTIVITY MATRIX KERNEL FOR A PERTURBED INHOMOGENEOUS PLASMA SHEATH. I. P. Shkarofsky (Radio Corp. of America. Missile and Surface Radar Div., Moorestown, N. J.). Chap. 13 of THEORETICAL STUDY OF HYDROMAGNETIC STABILITY AND TURBULENCE. INVESTIGATIONS AND DETAILED RESULTS. Annual Report, Period: January 1–December 31, 1961. 48p.

The stability of the Rosenbluth-Garwin plasma sheath is investigated. The flow of particles is subdivided into two classes, namely, particles moving towards the sheath and particles moving away from the sheath. The two classes of particles are first considered separately, then connected later. The simplifying assumption is made that ions do not take part in the perturbed oscillations. Assumption of delta-function velocity distribution for the particles leads to a zero pressure term in the force equation. On employing first order perturbation theory the problem is reduced to consideration of a vector integro-differential equation, whose coefficients involve integrals over equilibrium quantities as well as the frequency of the perturbation. For pure longitudinal waves propagating in the direction of the inhomogeneity, the equation is reduced to a fourth order differential equation whose coefficients are functions of independent variables. The general problem has as yet proven intractable. (auth)

22724 (AFSWC-TDR-62-12(Vol.II)(Chap.14)) STABILITY OF LONGITUDINAL WAVES IN A PERTURBED INHOMOGENEOUS PLASMA SHEATH. I. P. Shkarofsky (Radio Corp. of America. Missile and Surface Radar Div., Moorestown, N. J.). Chap. 14 of THEORETICAL STUDY OF HYDROMAGNETIC STABILITY AND TURBULENCE. INVESTIGATIONS AND DETAILED RESULTS. Annual Report, Period: January 1–December 31, 1961. 39p.

Longitudinal waves whose wavelength is compared with

the characteristic lengths of the equilibrium are investigated by the WKB approximation. This program is carried out as far as the determination of the WKB solution but there remains the problem of joining this solution appropriately to a perturbed solution outside the plasma. (auth)

22725 (AROD-2238:5) MAGNETIC FIELD INDUCED NEGATIVE RESISTANCE IN n-InSb. Interim Technical Report No. 1. Robert J. Phelan, Jr. (Colorado. Univ., Boulder). May 1962. 59p.

A negative resistance characteristic in n-InSb at liquid helium temperatures in transverse and longitudinal magnetic fields has been observed. The negative resistance characteristic is attributed to impact ionization of impurities and supported by variations of the Hall coefficient with the applied current. In addition, time delays, rise and decay times for the current have been studied, and an explanation in terms of the rate equation for ionization and recombination has been developed. The negative resistance characteristic has been used to generate oscillations, and, utilizing the control of the magnetic field, a crystal has performed as both a four and a two terminal switch. (auth)

22726 (LA-2700) UPPER LIMITS ON THE ROSSELAND MEAN OPACITY. David Liberman (Los Alamos Scientific Lab., N. Mex.). Apr. 16, 1962. Contract W-7405-eng-36. 17p.

Using sum rules from nonrelativistic quantum mechanics, five upper limits on the Rosseland mean opacity are calculated. One of them was obtained earlier by F. J. Dyson. (auth)

22727 (NP-11766) THE LOADING OF NUCLEAR EMULSIONS WITH BISMUTH. H. S. de Carvalho and M. Muchnik (Rome. Università). 1962. 5p. (Notas de Fisica Vol. IX, No. 1, p.1-4).

A method is described for loading nuclear emulsions with bismuth employing bismuth citrate. The bismuth citrate is first dissolved in ammonia before loading into the nuclear emulsion. The loading techniques thereafter are standard ones. (N.W.R.)

22728 (NYO-10134) A CLASS OF SOLVABLE POTENTIALS. A. Bhattacharjie and E. C. G. Sudarshan (Rochester, N. Y. Univ.). Apr. 18, 1962. Contract AT(30-1)-875. 20p.

A systematic method of constructing (velocity-independent) potentials, for which the s-wave Schrödinger equation can be solved in terms of known functions, is presented. Several such examples are constructed and the analytic structure of some of the corresponding scattering amplitudes worked out in detail. The use of Darboux's theorem allows a significant extension of the class of solvable potentials. (auth)

22729 (ORO-561) IONIZATION AND CHARGE TRANSFER CROSS SECTIONS. Technical Status Report No. 11, March 1, 1962–May 31, 1962. D. W. Martin, J. W. Hooper, D. S. Harmer, and R. A. Langley (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). June 1, 1962. Contract AT(40-1)-2591. 9p.

Problems arising in the modification of the thin target apparatus for use with heavier gases are discussed. The new miniaturized electrostatic collector assembly produced unsatisfactory results, but a further modification improved the situation. (T.R.H.)

22730 (TID-16109) GROUND STATE OF THE HELIUM ATOM. Technical Report No. 4. Charles L. Schwartz (California. Univ., Berkeley). June 1, 1962. 10p. Project DEFENDER.

In an attempt to analyze the rate of convergence of Rayleigh-Ritz variational calculations on the ground state of helium, the usefulness of inserting fractional powers of the variables into the conventional Hylleraas series was re-investigated. The results were very successful: with a 164 term trial function containing half powers of the variable $s = r_1 + r_2$, the best eigenvalue previously obtained was matched. The extrapolated value for the nonrelativistic eigenvalue is -2.9037243771 atomic units, with an estimated uncertainty of about $1/10^{10}$. (auth)

22731 (TID-16132) STUDIES OF POINT DEFECTS IN SILVER CHLORIDE. H. Layer and L. Slifkin (North Carolina. Univ., Chapel Hill). [1962]. 11p. (AFOSR-2644)

Experiments were made on excess point defects introduced into single crystals of silver chloride by pulsed plastic extension or by rapid cooling from high temperature. Point defects are created by plastic deformation much less efficiently in silver chloride than in other substances that have been studied. Interstitial silver ions so produced have a lifetime of the order of 10^8 jumps. Rapid cooling of very pure silver chloride quenches in approximately 0.1% Schottky defects. The silver and chloride vacancies are almost completely associated at room temperature. These divacancies have an activation energy for migration of 23 kcal/mole and a dissociation energy of 9.8 kcal/mole. (auth)

22732 (ZPh-113) ELECTRON IMPACT IONIZATION OF ATOMIC HYDROGEN AND ATOMIC OXYGEN. Erhard W. Rothe, Lawrence L. Marino, R. H. Neynaber, and S. M. Trujillo (General Dynamics/Convair, San Diego, Calif.). Aug. 15, 1961. Contract DA-04-495-ORD-3112. 10p. (AD-269408)

Total cross sections for the ionization of atomic oxygen and hydrogen were measured by a modulated molecular beam technique. The impact energies were 100 to 500 ev for oxygen and 100 to 750 ev for hydrogen. The number of ions formed in a region defined by the intersection of an electron beam and a modulated molecular beam was compared with the number formed when the neutral beam was partially dissociated. All ions were collected, including those energetic ions formed in dissociative ionization. The degree of dissociation was measured with a mass spectrometer. From the data, the ratio of the atomic to the molecular ionization cross sections were obtained. The absolute atomic values were calculated by multiplying these ratios by molecular ionization cross sections determined by others. The results are compared with theoretical estimates and previous experimental determinations. (auth)

22733 (AD-266655) CONTRIBUTION TO THE STUDY OF THE NATURE OF THE EMISSION CENTERS OF EXO-ELECTRONS. Paul Petrescu. Translated from Acad. rep. populare Romîne, Inst. fiz. atomică si Inst. fiz., Studii cercetări fiz., 11: 867-78(1960). 23p.

Some results which can be obtained by applying some criteria in the interpretation of certain experiments about the nature of the emission centers of exoelectrons are presented. (auth)

22734 (AEC-tr-5176) ELECTROOSMOSIS AND PASSAGE POTENTIAL THROUGH DOUBLE-LAYER POWDER DIAPHRAGMS. K. P. Tikhomolova. Translated by A. L. Monks (Oak Ridge National Lab., Tenn.) from Vestnik Leningrad. Univ., 15: No. 4, Ser. Fiz. i Khim., No. 1, 106-16(1960). 16p.

A marked asymmetry of the electrokinetic effects in two-layer powder membranes with different particle size in each layer has been detected. These effects depend upon

the direction of the current or the motion of a liquid. Such an asymmetry can be explained by taking into account the change of physical conditions for the liquid passing through the boundary between the layers. (auth)

22735 (AEC-tr-5196) FORM OF COMPRESSION SHOCKS IN FREELY EXPANDING GAS JETS. Konrad Bier and Berndt Schmidt. Translated for Oak Ridge National Lab., Tenn. from Z. angew. Phys., 13: 493-500 (1961). 25p.

A Schlieren photography study was made of the compression shocks appearing in freely expanding gas jets at greater expansion ratios. It was shown that characteristic linear dimensions of the compression shocks increase approximately with the square root of the expansion ratio (p_0/p_1) for rotation-symmetrical gas jets at terminal mach 1 and $p_0/p_1 = 10$ to 10^3. With N_2, H_2, Ar, and CO_2, identical values result for distance of shock from nozzle orifice within error limits, although characteristic diameters increase with increasing specific heat of the gas. In plane jets the linear dimensions standardized to jet width, however they are considerably greater and increase more with increasing p_0/p_1. A stripper orifice, as used in producing molecular beams and in separation nozzles, was studied for the plane and rotation-symmetrical cases. If the stripper edge is closer to the orifice than the flow bulge of undisturbed flow, an oblique shock forms adjacent to the edge of the outside of the stripper while a flow pattern similar to a free expansion at terminal mach 1 results behind the orifice. For a greater stripper distance, the compression shock system is partly drawn into the stripper and a distinct separation of the shock before and behind the stripper cannot be established. Calculations based on a pressure-condition in the vicinity of hypersound formulated by Adamson and Nicholls are combined with the relation obtained from the Schlieren study to plot mach number versus nozzle distance. (T.R.H.)

22736 (FTD-TT-62-415) THERMODYNAMIC FUNCTIONS OF MONATOMIC AND DIATOMIC GASES IN A WIDE TEMPERATURE RANGE. V. ALKALI METALS IN THE IDEAL-GAS STATE TO 10,000°K. L. V. Gurvich, V. A. Kvlividze, and N. P. Rtishcheva. Translated from Zhur. Tekh. Fiz., 36: 219-22(1962). 7p.

Thermodynamic functions of vaporized Li, Na, K, Rb, and Cs (Φ_T^*, S_T^0, $H_T^0 - H_0^0$) up to 10000°K were calculated and the values are tabulated. In calculating the statistical sums and their derivatives, all the electron states of the atoms of the gases under consideration, states associated with the transition of the valence electron of an atom to states with a principal quantum under $n \leq n_{max}$, where $n_{max} 32.461 \times T^{1/4}$, were calculated. Log K_p values for the ionization of vaporized alkali metals ($M \rightleftharpoons M^+ + \bar{e}$) are also given. (P.C.H.)

22737 (UCRL-Trans-829(L)) SELF-DIFFUSION OF IONS IN POLYCRYSTALLINE ALKALI HALIDES. J. F. Laurent and J. Benard. Translated by Sergey Shewchuck (Univ. of California Lawrence Radiation Lab., Berkeley) from Phys. and Chem. Solids, 7: 218-27(1958). 21p.

A study of self-diffusion of ions in polycrystalline alkali halides of different particle size has been made as a function of temperature. In every case, the activation energy for self-diffusion of the ions is the same whether migration takes place in single crystals or polycrystals. For all compounds, with the exception of the salts of cesium, the speed of diffusion of the cation is the same for single or polycrystals. By contrast, the migration rate of the anions increases as the mean dimensions of the crystals comprising the polycrystalline aggregates become smaller. However, in the case of the cesium salts the speed of diffusion of the cation is equally influenced by the presence of intercrystalline boundaries. It is possible to connect this increase in the speed of diffusion with the polarization of the ions. The more the ion is polarized, the greater the influence of the intercrystalline surfaces, irrespective of the polarity of the diffusion ion. An autoradiographic study confirms these conclusions. (auth)

22738 A CONTINUOUS ABSORPTION COEFFICIENT OF NEGATIVE HYDROGEN AND LITHIUM IONS. T. Tietz (Univ. of Łódź, Poland). Acta Phys. Acad. Sci. Hung., 14: 1-9(1962). (In English)

Calculations of the continuous absorption coefficient of H^- were based on ground state wave functions obtained by the Ritz variational method. The calculation of the continuous absorption coefficient of negative hydrogen and lithium ions was simplified, using a cut off Coulomb potential. Only numerical values were obtained. A simple analytical expression for the continuous absorption coefficient of negative hydrogen and lithium ions is given. Results compared favorably with accurate numerical values. (auth)

22739 A NEW CONCEPTION OF THE GRAVITATIONAL FIELD. A. M. Brodskii, D. Ivanenko, and H. A. Sokolik (Moscow State Univ.). Acta Phys. Acad. Sci. Hung., 14: 21-5(1962). (In English)

The method for the introduction of compensating boson vector fields can be generalized for a tensor field of zero rest mass, which can be interpreted essentially as a gravitational field. (auth)

22740 A MODEL WITH SUPERCONDUCTING SOLUTION IN QUANTUM FIELD THEORY. G. Marx (Roland Eötvös Univ., Budapest). Acta Phys. Acad. Sci. Hung., 14: 27-38(1962). (In English)

By considering a theory based on a simple model, the mathematical possibilities are analyzed for the case in which the same energy operator may have in quantum theory two (approximatively) orthogonal ground states and eigenfunction systems. The consequences for the elementary particle physics are discussed. (auth)

22741 ELECTRON CORRELATION IN METALS: DENSITY MATRIX APPROACH. N. H. March and S. Sampanthar (Univ. of Sheffield, Eng.). Acta Phys. Acad. Sci. Hung., 14: 67-76(1962). (In English)

The conceptual simplicity gained using density matrices to describe the ground state of an electron gas moving in the field of a uniform background of positive charge (Sommerfeld model of a metal) is stressed. The diagonal element of the second-order density matrix (pair function) for a low-density electron gas is considered; to a similar degree of approximation, the first-order matrix and hence the momentum distribution may be obtained. In the high-density limit, where perturbation theory is valid, Daniel and Vosko (Phys. Rev., 120: 2041(1960)) discussed the way in which the momentum distribution develops from the Fermi forms as the density is lowered (or the interaction switched on). A calculation yielding the pair function to the same degree of approximation is reported, the results being obtained using Green's functions, which are closely related to density matrices. The range of usefulness of the concept of the Fermi surface in an interacting electron gas is discussed. (auth)

22742 ON THE CORRELATION CORRECTION OF STATISTICAL ATOMIC MODELS. P. Gombás (Universität für Technische Wissenschaften, Budapest). Acta Phys. Acad. Sci. Hung., 14: 83-90(1962). (In German)

Statistical atomic-model equations were expanded using the correlation correction. The equations are extended to

further atoms and ions; approximate solutions are presented. (L.N.N.)

22743 REMARKS ON A NEW VARIATIONAL METHOD. M.-C. Bouten-Denys (CEN, Mol, Belg.). Bull. classe sci., Acad. roy. Belg, (5), 47: 1009-14(1961). (In English)

The problem of the order of the energy levels in Yamasaki's new variational method is investigated. From an example taking Weber functions as trial functions, it is shown that an ordering theorem like that of MacDonald does not exist for this method. Considerably improved results are obtained by using the eigenfunctions of a more similar potential well as trial functions. (auth)

22744 KINETICS OF THE FAST COMPONENT OF SCINTILLATION IN A PURE ORGANIC MEDIUM. APPLICATION TO THE CASE OF ANTHRACENE. Daniel Blanc, Francis Cambou, and Yann Gervais de Lafond (Faculté des Sciences, Toulouse, France). Compt. rend., 18: 3187-9(Apr. 30, 1962). (In French)

The general equation for the variation of density $n(\underline{r},t)$ of excitation quanta at a point M placed at a distanced $\underline{r}$ along the trajectory is resolved by neglecting only the molecular deexcitation. The equation for specific luminous is derived and applied to an anthracene crystal. Excitation and deexcitation by strongly ionizing particles are determined, and the results for anthracene are shown graphically. (J.S.R.)

22745 $Na(Nb_{1-x}V_x)O_3$ SYSTEM AND "FERRIELECTRICITY." Robert C. Miller, Elizabeth A. Wood, Joseph P. Remeika, and Albert Savage (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 33: 1623-30(May 1962).

Crystals of pure $NaNbO_3$ and $Na(Nb_{1-x}V_x)O_3$ were investigated electrically, optically, and by x-ray diffraction. Attempts to introduce amounts of vanadium larger than $x \approx 0.005$ into the crystals were unsuccessful. The room-temperature phase of pure $NaNbO_3$ was antiferroelectric, that of $NaVO_3$ nonferroelectric but perhaps also antiferroelectric. The vanadium-doped crystals appeared to be antiferroelectric in the room-temperature as-grown state. A transition to a ferroelectric phase could be induced in both the vanadium-doped and pure crystals by a sufficiently high field (of the order of 50 kv/cm), called the transition field, applied normal to the orthorhombic b axis. In one type of crystal plate, when the field-induced transition into the ferroelectric phase occurred, a crystallographic reorientation was also observed. Some crystals reverted to the nonferroelectric phase when the transition field was removed. All of the crystals investigated, while in the ferroelectric phase, were found to have the length of the b axis twice the length of the simple perovskite cube, whereas in the antiferroelectric phase, the length of the b axis was four times that of the simple perovskite cube. In so far as the phenomena studied were concerned, it could be stated that the vanadium-doped crystals behaved in most respects like pure $NaNbO_3$ crystals. In particular, no evidence was found for an unbalanced antidipole configuration, i.e., "ferrielectric" structure. (auth)

22746 SECONDARY ELECTRON PRODUCTION FROM FISSION FRAGMENTS EMERGING FROM THIN LAYERS OF URANIUM DIOXIDE. James N. Anno (Battelle Memorial Inst., Columbus, Ohio). J. Appl. Phys., 33: 1678-81 (May 1962).

Measurements of the currents leaving thin films of uranium dioxide undergoing a known rate of fission determined the secondary electron yield from fission fragments emerging from the films. This yield was found to vary from about 570 to 300 electrons per fragment over a film thickness from 0.1 to 3 microns. The ratio of charge carried by the secondary electrons emitted from the surface to the charge carried by fission fragments was also determined. This ratio varied slowly with film thickness, from 28 for a 0.1-micron coating to about 21 for a 3-micron coating. The behavior of the charge ratio and secondary electron yield with coating thickness was in qualitative agreement with theory. (auth)

22747 SOLUTION OF THE SPACE CHARGE PROBLEM FOR A PULSED TOWNSEND DISCHARGE. J. A. Morrison and D. Edelson (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 33: 1714-20(May 1962).

The pulsed Townsend discharge technique for the determination of electron attachment coefficients of electronegative gases is examined for situations where the ion density is sufficiently high that space charge effects must be considered. The equations of motion for the ions are solved to yield a first-order differential equation for a parametric function, in terms of which the current and boundary position may be expressed. For the particular case of an initial distribution which decays exponentially from the cathode, an exact solution for the current is obtained by numerical evaluation of this fuction. Comparison with experiment shows qualitative and quantitative agreement. (auth)

22748 ELECTRON MICROSCOPE DIAGNOSTICS OF THIN FILM SPUTTERING. D. B. Medved (General Dynamics/Convair, San Diego, Calif.) and H. Poppa. J. Appl. Phys., 33: 1759-63(May 1962).

A technique for measuring relative changes in thin-film thickness is utilized as a means of monitoring sputtering yields at low energies. The apparatus consists of an electron microscope with an ion source attached to it, which allows exposure of the specimen to ion bombardment before and after monitoring transmission current of electrons through it. Operating the microscope in the selected area diffraction mode, the electron beam current is monitored by a Faraday cup placed in the microscope at the position of the final diffraction pattern image. Relative changes in thickness as low as 4 Å for 100-Å films are measured. A scanning technique avoids contamination buildup during the electron transmission measurement. The specimens monitored show a high degree of uniformity with variations in sample thickness less than the estimated error of the measurement. The sensitivity of this method is limited only by available ion current densities rather than total current to the specimen. In principle, mass losses of 2×10^{-14} g are detectable by the electron beam probe of 2 μ diameter. The apparatus may be applied to measuring sputtering yields of polycrystalline silver thin films as a function of energy at normal incidence utilizing argon, krypton, and neon as the bombarding ions. The sputtering yields for Kr^+ ions on Ag are intermediate to that of Ar^+ and Ne^+. At 30 ev $S \approx 2 \times 10^{-4}$ for Kr^+ on Ag. (auth)

22749 THRESHOLD ENERGIES IN MECHANICAL COLLISION THEORIES OF CATHODE SPUTTERING. Erich B. Henschke (Aeronautical Systems Div., Wright-Patterson AFB, Ohio). J. Appl. Phys., 33: 1773-8(May 1962).

It is shown that the very low threshold energies for sputtering measured with highly sensitive methods (surface ionization, radioactive deposits, or spectroscopic method), immediately after applying a "clean-up" sputtering with higher ion energy, are caused by the fact that the applied intermediate sputtering produces on the target's uppermost surface atoms with reduced binding energies ranging from a maximum to a minimum number of bonds. The

lowest ion energy at which a yield can be measured in the described manner, is just sufficient to remove the latter atoms and is defined as the "minimum-bond" threshold. The thresholds determined for polycrystalline targets at normal ion incidence without intermediate sputtering correspond to the so-called "full-plane" thresholds and represent the lowest ion energies at which continuous (i.e., plane by plane) sputtering of the target surface is feasible. The ratios of the "full-plant" thresholds to the "minimum-bond" thresholds, the latter measured at exclusively normal ion incidence with a sensitive method after intermediate sputtering with a higher ion energy, are assumed to be the same (about 2 : 1) as calculated for a polycrystalline surface from the ratio of the binding energies of an atom in a full plane to the binding energies of an atom on top of a full-plane area. Incorrect larger ratios (about 3 : 1), as measured with highly sensitive methods, are shown to be probably caused by doubly-charged ions and oblique ion incidence, which are exclusively active at the lowest ion energies. (auth)

22750 ELECTRON STREAMS IN AN OSCILLATING ELECTRIC FIELD. W. Sackinger (Cornell Univ., Ithaca, N. Y.). J. Appl. Phys., 33: 1784-6 (May 1962).

A general theoretical expression is derived for an electron trajectory in an oscillating electric field. This result is extended to an electron stream, and the current and velocity are found exactly, in the absence of space charge, for any plane within the region of the oscillating field. The limits on the validity of the analysis are established, and application is made to the parallel-plane diode or klystron gridded gap. Within the restriction that the normalized gap voltage be less than the normalized gap length, exact results for current and velocity are obtained. (auth)

22751 APPLICATION OF A FERROELECTRIC MATERIAL IN AN ENERGY CONVERSION DEVICE. J. D. Childress (General Dynamics/Fort Worth, Fort Worth, Tex.). J. Appl. Phys., 33: 1793-8 (May 1962).

The thermodielectric converter, a device employing a ferroelectric material as the active element in converting thermal to electrical energy, is analyzed. The efficiency and power-handling capacity are calculated for operation of a ferroelectric material in the induced-ferroelectric region on the basis of an idealization of the polarization characteristics. The idealization includes the induced-ferroelectric transition but excludes hysteresis and other nonlinear effects. For a barium titanate-like material, the following values are obtained: a maximum theoretical efficiency of about 0.5% in an ideal temperature cycle of Carnot efficiency 7.1%; and a power-handling capacity of roughly 32 w/lb per temperature cycle per sec. (auth)

22752 CONFIGURATIONS OF SUPERCONDUCTING SHELLS REQUIRED FOR NEAR CRITICAL UNIFORM MAGNETIC FIELDS. Alvin F. Hilderbrandt, Hugo Wahlquist, and Daniel D. Elleman (California Inst. of Tech., Pasadena). J. Appl. Phys., 33: 1798-1800 (May 1962).

The boundary value problem for a superconductor is solved for specific axially symmetric geometries. The interior field of a right circular shell is found to be quite uniform. Also it is found that the ends of the shell can be shaped to overcome a singularity at the end. This analysis permits a near-critical and uniform field to be obtained over a very large volume of the central region. Experimentally it is found that a simple geometric shape electrolytically coated with lead will trap a field of 630 gauss with homogeneity in agreement with calculation. (auth)

22753 SPUTTERING YIELDS FOR LOW ENERGY He^+-, Kr^+- AND Xe^+-ION BOMBARDMENT. D. Rosenberg and G. K. Wehner (General Mills, Minneapolis). J. Appl. Phys., 33: 1842-5 (May 1962).

Sputtering yields of various metals are determined for He^+, Kr^+, and Xe^+ ion bombardment in the energy range 100 to 600 ev. Yields at 400 ev show a periodic dependence on atomic number, similar to that of the reciprocals of the heats of sublimation. (auth)

22754 NITROGEN ION BOMBARDMENT OF THIN Pt FILMS. J. O. Stiegler and T. S. Noggle (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 33: 1894-5 (May 1962).

Nitrogen-ion beams at 24 Mev are used to bombard Pt films less than 25 Å thick. The N ions have trajectories parallel to the plane of the film. The bombardment produces light, narrow tracks in the film, showing that material is removed from the track region. Differences between these results and results using fission fragments, which have wide, high-contrast tracks, indicate that the mechanism for material removal is not thermal (i.e., electron excitation), but may consist of a charge interaction between the moving ion and the surface layers of the film. (T.F.H.)

22755 SUPERCONDUCTIVE FILMS MADE BY PROTECTED SPUTTERING OF TANTALUM OR NIOBIUM. Rudolf Frerichs (Northwestern Univ., Evanston, Ill.). J. Appl. Phys., 33: 1898-9 (May 1962).

Electrodes of the material to be sputtered are placed one above the other in a 0.1 to 0.2 mm Hg Ar atmosphere. Substrates for the deposited layers are placed on the lower electrode. An asymmetric alternating current first causes the Ar to sputter the upper electrode with a current density $J = 0.5$ ma/cm^2, which causes a thin layer to be deposited on the substrate; next, the current reverses and Ar bombards the substrate and thin deposited layer with $J = 0.1$ ma/cm^2, thus driving out impurities from the deposited layer. This method circumvents the strong gettering action of sputtered Ta and Nb. The superconducting properties of the films formed by this process are discussed. (T.F.H.)

22756 PRELIMINARY STUDIES OF CATHODE SPOT BEHAVIOR ON THIN FILM ELECTRODES. David L. Hutchins and Joseph C. Newton (Sandia Corp., Albuquerque, N. Mex.). J. Appl. Phys., 33: 1903 (May 1962).

Pulsed (0.5 to 10 μsec) electric arcs with currents of 1 to 10 amp are used to study the cathode-spot behavior of Ti-film cathodes at 10^{-7} mm Hg. The cathode spot pattern observed on the Ti consists of a group of dendritic paths radiating outward from a common origin, adjacent to which is a large crescent-shaped area. The dendritic structure is dependent on the current pulse duration and amplitude, while the crescent-shaped area is not. The velocity of the cathode spot is estimated as 10^4 cm/sec. (T.F.H.)

22757 SPUTTERING OF GOLD BY LOW ENERGY INERT GAS IONS. H. G. Scott (Univ. of Melbourne). J. Appl. Phys., 33: 2011-15 (June 1962).

The sputtering yield of Au bombarded by 20 to 100 ev He, Ne, and Ar ions was measured by the increase in electrical resistance of a thin Au film. For Ne and Ar, the yield decreases rapidly with decreasing ion energy from 100 to 40 ev; below 40 ev, the decrease is less rapid and no definite threshold was found. For 40-ev Ne ions, the yield is proportional to the ion current density; for Ar ions at this energy, the yield is independent of the current. For currents greater than 100 μa/cm^2, Ne is more efficient than Ar in sputtering Au. To explain the variation yield with ion current for low-energy Ne ions, it is suggested that the sputtering may take place by a two-stage process: the first stage being the creation of defects in the Au by the ions, and the second stage, ejection of Au atoms from the neighborhood of these defects. (auth)

22758 ATOM EJECTION IN LOW ENERGY SPUTTERING OF SINGLE CRYSTALS OF fcc METALS AND OF Ge AND Si. G. S. Anderson (General Mills Electronics Group, Minneapolis). J. Appl. Phys., 33: 2017-25(June 1962).

The spatial distribution of atoms ejected from low-index planes of Cu, Ni, Au, Al, Ge, and Si were studied for bombardment by Hg^+, Ne^+, and Ar^+ to 800 ev. The atom ejection for Hg^+ bombardment of Ge planes (12° apart) belonging to the ⟨110⟩ zone was investigated. For the fcc crystals, ejection was observed in ⟨110⟩ directions at all energies, in ⟨100⟩ directions at higher energies, and in ⟨411⟩ directions under certain conditions. The ejection in the ⟨110⟩ and ⟨100⟩ directions is the result of focusons intercepting the surface with sufficient energy to cause a surface atom to be ejected. For atom ejection in ⟨411⟩ directions, a ⟨110⟩ focuson may intercept and eject a surface atom which is in a twin position rather than a normal position. For ion bombardment of Ge and Si, atom ejection is observed in ⟨111⟩ and ⟨100⟩ directions. Possibly many of the natural interstitial positions are filled near the surface as a result of the bombardment and the structure resembles more that of a bcc structure. The systematic deviation in ejection directions from the associated crystallographic direction observed for the Hg^+ bombardment of Ge surfaces suggests that the atomic collisions resulting in atom ejection for Ge and Si occur in outer surface layers. (auth)

22759 THERMIONIC EMISSION FROM MOLYBDENUM IN VAPORS OF CESIUM AND CESIUM FLUORIDE. R. L. Arnodt, L. J. Brown, and B. D. Nichols (Los Alamos Scientific Lab., N. Mex.). J. Appl. Phys., 33: 2080-5(June 1962).

"S curves", similar to those for electron emission from W in Cs vapor, are presented for electron emission from Mo in Cs vapor. The addition of CsF enhances the electron emission. The minimum effective work function of the Cs-CsF-Mo surface is 1.38 ± 0.05 ev, while that of the Cs-Mo surface is 1.68 ± 0.05 ev. The new cathode may be useful in thermionic converters. (auth)

22760 MECHANISM OF THE PENNING DISCHARGE AT LOW PRESSURES. W. Knauer (Hughes Research Labs., Malibu, Calif.). J. Appl. Phys., 33: 2093-9(June 1962).

Experiments were conducted using a cold-cathode Penning discharge in which the sputtering patterns, the direction of ion motion, the energy distribution of the ions, and the E × B electron rotation were studied. Below 10^{-4} mm Hg, the discharge consists essentially of a pronounced, rotating plasma sheath close to the anode, while most of the center portion of the discharge is depressed to near-cathode potential. At 3000 v and 2500 gauss, an average rotation frequency of the sheath of 70 Mc was observed. This corresponds to an average field strength in the sheath of 8800 v/cm. An approximate computation indicates that in the presence of fields of this magnitude, classical cross-field mobility can account for the anode currents observed. This result differs from findings at higher pressures, at which random-field-enhanced diffusion had to be postulated to explain the large anode currents. (auth)

22761 ON MEASURING THE PHASE VELOCITY OF AN OSCILLATING GRAVITATIONAL FIELD. John C. Cook (Southwest Research Inst., San Antonio). J. Franklin Inst., 273: 453-71(June 1962).

Laboratory experiments to determine the "propagation velocity of gravitation" were proposed. All would employ the oscillating, conservative "near field" of massive "revolving dumbbell" transmitters, and resonant pendulum receivers. The propagation time of the gravitational field would be measured in terms of minute phase differences. The result should constitute an independent check of the General Theory of Relativity. Formulas for dynamical effects influencing the design of the experiment are derived. These include the receiver amplitude and phase stability, starting transients, and transmitter harmonics. Special experimental techniques are surveyed. These include signal steepening, reversing the direction of transmitter revolution, slaving the transmitter to a receiver, phase measurement by signal subtraction, and null measurements using opposed transmitters. A low frequency of operation (<1 cycle/sec) would be best. The practical difficulties in such an experiment would be great but not insurmountable. (auth)

22762 THE PHYSICAL BASIS OF QUANTUM FIELD THEORY. Alladi Ramakrishnan, T. K. Radha, and R. Thunga (Inst. of Mathematical Sciences, Madras). J. Math. Anal. and Appls., 4: 494-26(June 1962).

Development of quantum field theory from wave mechanics is discussed. Axioms and postulates of field theory are suggested by physical considerations. Ways in which the Pauli principle is imbedded in the field theoretic and Feynman formalisms are discussed. (L.N.N.)

22763 A CONVERGENT PERTURBATION EXPANSION IN FIRST-QUANTIZED ELECTRODYNAMICS. Howard R. Reiss (Naval Ordnance Lab., Silver Springs, Md. and Univ. of Maryland, College Park). J. Math. Phys., 3: 387-95(May-June 1962).

It is shown that a real physical problem exists which, when calculated in first-quantized electrodynamics, possesses a convergent perturbation expansion. The result is demonstrated by proving the analyticity, in a region of nonzero radius about the origin in the complex coupling-constant plane, of the transition probability for pair creation by two electromagnetic fields. Some singularities in the complex plane are located, which limit the radius of convergence only for a discrete set of values for the energies of the electromagnetic fields that define the problem. (auth)

22764 GREEN'S DISTRIBUTIONS AND THE CAUCHY PROBLEM FOR THE ITERATED KLEIN-GORDON OPERATOR. John Judson Bowman and Joseph David Harris (Dartmouth Coll. and Dartmouth Medical School, Hanover). J. Math. Phys., 3: 396-404(May-June 1962).

An explicit form of the homogeneous Green's function for the multi-dimensional iterated Klein-Gordon operator is obtained. By a direct calculation from its Fourier representation, the Green's function is expressed as a one-dimensional infinite integral of the Sonine type. Although this integral is classically divergent when the order of the operator is less than the number of space dimensions, it can be treated rigorously under these conditions using the concepts of distribution analysis. A generalized Sonine integral is developed and the result applied to obtaining an explicit expression for the Green's function, which is now to be regarded as a distribution in the sense of Schwartz. Using a distribution introduced for this purpose, the Green's function is written in a form which explicitly displays its singularities on the light cone. The well-known difference between even-and odd-dimensional spaces is reflected in the nature of these singularities. The singularities appearing for an odd number of space dimensions consist of a finite linear combination of derivatives of the Dirac delta function $\delta(s^2)$ where s is the space-time distance. The highest derivative appearing is of order $\frac{1}{2}(n-21-1)$ with n giving the number of space dimensions and 21 giving the order of the operator. The singular part for even-dimensional spaces consists of a

polynomial in 1/s of degree n − 2l + 1. No singularities appear when the order of the operator is greater than the number of dimensions. The general solution of Cauchy's problem for the iterated Klein-Gordon operator is obtained in convolution form. An explicit solution for the ordinary Klein-Gordon equation is presented in a form which exhibits separately the contributions due to the singular part and the regular part of the Green's function. (auth)

22765 SIMPLE REALIZATIONS OF THE INFINITESIMAL GENERATORS OF THE PROPER ORTHOCHRONOUS INHOMOGENEOUS LORENTZ GROUP FOR MASS ZERO. J. S. Lomont (Polytechnic Inst., Brooklyn) and H. E. Moses. J. Math. Phys., 3: 405-8(May-June 1962).

A realization of the infinitesimal generators for the mass-zero case of the proper orthochronous inhomogeneous Lorentz group is given explicitly for both continuous and discrete spin cases in terms of a uniform notation. The unitarity properties of the realization for the discrete spin case are noted. For the sake of completeness the infinitesimal generators for the case of nonzero mass are also given. Hence, realizations are included for all irreducible unitary representations of the inhomogeneous Lorentz group of physical interest. Since the irreducible representations of the two-dimensional Euclidean group play an important role in the massless case, simple realizations of the irreducible representations of the generators of this group are also given. (auth)

22766 PROPERTIES OF THE IRREDUCIBLE ANGULAR MOMENTUM TENSORS. M. E. Rose (Univ. of Virginia, Charlottesville). J. Math. Phys., 3: 409-13 (May-June 1962).

The angular momentum operators define a set of irreducible tensors that are unique except for a normalization constant. The normalization is conveniently defined in terms of statistical tensors that describe oriented states. The properties of the tensors discussed include: the trace of products of components of such tensors; symmetry properties of the traces; and the expansion of products of components of these tensors into a sum of irreducible tensors. The corresponding expansion of commutators and anticommutators of these components is also discussed. (auth)

22767 A PROCEDURE FOR ESTIMATING EIGENVALUES. Norman W. Bazley (National Bureau of Standards, Washington, D. C.) and David W. Fox. J. Math Phys., 3: 469-71(May-June 1962).

A procedure is given for calculation of lower bounds to the eigenvalues of self-adjoint operators. Computation of the lower bounds is reduced to the solution of linear algebraic problems. (auth)

22768 STOCHASTIC MODELS FOR MANY-BODY SYSTEMS. I. INFINITE SYSTEMS IN THERMAL EQUILIBRIUM. Robert H. Kraichnan (New York Univ., New York). J. Math. Phys., 3: 475-95(May-June 1962).

Some model Hamiltonians are proposed for quantum-mechanical many-body systems with pairing forces. In the case of an infinite system in thermal equilibrium, the Hamiltonians lead to temperature-domain propagator expansions that are expressible by closed, formally exact equations. The expansions are identical with infinite subclasses of terms from the propagator expansion for the true many-body problem. The two principal models introduced correspond, respectively, to ring and ladder summations from the true propagator expansion, augmented by infinite classes of self-energy corrections. The latter are expected to yield damping of single-particle excitations. The eigenvalues of the ring and ladder model Hamiltonians are real, and they are bounded from below if the pair potential obeys certain conditions. The models are formulated for fermions, bosons, and distinguishable particles. In addition to the ring and ladder models, two simpler types are discussed, one of which yields the Hartree-Fock approximation to the true problem. A novel feature of all the model Hamiltonians (except the Hartree-Fock) is that they contain an infinite number of parameters whose phases are fixed by random choices. Explicit closed expressions are obtained for the Helmholtz free energy of all the models in the classical limit. (auth)

22769 STOCHASTIC MODELS FOR MANY-BODY SYSTEMS. II. FINITE SYSTEMS AND STATISTICAL NONEQUILIBRIUM. Robert H. Kraichnan (New York Univ., New York). J. Math. Phys., 3: 496-521(May-June 1962).

Some model Hamiltonians proposed for quantum-mechanical many-body systems with pair forces are considered. For infinite systems in thermal equilibrium, they lead to temperature-domain propagator expansions that are formally summable and expressible by closed equations. These expansions are identical with infinite subclasses of terms from the propagator expansion for the true many-body problem. The two principal models correspond to ring- and ladder-diagram summations from the true propagator expansion, augmented by infinite classes of self-energy corrections. The model Hamiltonians are called stochastic because they contain parameters whose phases are fixed by random choices. More general models are formulated that yield formally summable propagator expansions for finite systems. The analysis is extended to correlation and Green's functions defined for nonequilibrium ensembles. The nonequilibrium treatment is developed in the Heisenberg representation in such a way that unlinked diagrams do not arise. A basic convergence question associated with the formal closed equations for the model propagators and correlation functions is examined by means of finite-difference integration of the Heisenberg equations of motion. This procedure appears to converge independently of whether the perturbation expansions for the propagators and correlation functions converge. It yields substantial support for the validity of the formal closed model equations. (auth)

22770 ASYMPTOTIC EXPANSION OF THE BARDEEN-COOPER-SCHRIEFFER PARTITION FUNCTION BY MEANS OF THE FUNCTIONAL METHOD. Bernhard Muehlschlegel (Univ. of Illinois, Urbana). J. Math. Phys., 3: 522-30(May-June 1962).

The canonical operator exp $[-\beta(\mathcal{H} - \mu N)]$ associated with the Bardeen-Cooper-Schrieffer (BCS) model Hamiltonian of superconductivity is represented as a functional integral by the use of Feynman's ordering parameter. General properties of the partition function in this representation are discussed. Taking the inverse volume of the system as an expansion parameter, it is possible to calculate the thermodynamic potential including terms independent of the volume. This yields proof that the BCS variational value is asymptotically exact. The behavior of the canonical operator for large volume is described and related to the state of free quasiparticles. A study of the terms of the thermodynamic potential that are of smaller order in the volume in the low-temperature limit shows that the ground state energy is nondegenerate and belongs to a number eigenstate. (auth)

22771 ANTISYMMETRIC FUNCTIONS AND SLATER DETERMINANTS. Leslie L. Foldy (Case Inst. of Tech., Cleveland). J. Math. Phys., 3: 531-9(May-June 1962).

Given a function w completely antisymmetric in n vari-

ables, there may exist a set of n functions of one variable such that the given function is a Slater determinant in the latter. The first problem considered is that of obtaining a criterion for this to be the case for a given function. This problem is solved by considering the function w as a mapping of the space of functions in $n-1$ variables onto the space of functions of one variable. A necessary and sufficient condition for the initial function to be a Slater determinant is then shown to be that the image space be n dimensional. This criterion is converted into algorithms that can be employed for the determination. The application of one of these algorithms yields the theorem that an arbitrary linear combination of the $n+1$ Slater determinants in n variables formed from $n+1$ one-variable functions can always be written as a single Slater determinant. It is further proved that if the image space of the mapping is $m(>n)$ dimensional, the original function can be expressed as a linear combination of $m!/(m-n)!n!$ Slater determinants in n variables formed from m one-variable functions. Playing an important role in the analysis is the product of the described mapping by its adjoint (the product is simply related to Dirac's density matrix for a quantum mechanical system of identical particles), as well as the eigenvectors and eigenvalues of this Hermitian positive semidefinite mapping. The latter form a basis for a systematic approximation procedure for representing a given function by a single Slater determinant or by sums of Slater determinants formed from a particular number of one-variable functions. Problems of simultaneous approximation of sets of antisymmetric functions and possible physical applications to many-fermion systems are discussed. (auth)

22772 DOUBLE-TENSOR OPERATORS FOR CONFIGURATIONS OF EQUIVALENT ELECTRONS. B. R. Judd (Univ. of California, Berkeley). J. Math. Phys., 3: 557-63(May-June 1962). (UCRL-9868)

To every irreducible representation W of the rotation group in $2l+1$ dimensions that is used to classify states of the electronic configurations l^n, there corresponds two couples (v,S), where v and S stand for the seniority number and total spin, respectively. Determinantal product states are introduced to examine this correspondence in detail. It is shown that for two double tensors $W^{(\kappa k)}$ and $W^{(\kappa' k)}$, the set of reduced matrix elements $(l^n v_1 W \xi S_1 L \| W^{(\kappa k)} \| l^n v_1' W' \xi' S_1' L')$, for fixed n, v_1, v_1', W, and W', is proportional to the set $(l^m v_2 W \xi S_2 L \| W^{(\kappa' k)} \| l^m v_2' W' \xi' S_2' L')$. ξ and ξ' are additional labels that may be required to define the states uniquely, provided the two couples (v_1, S_1) and (v_2, S_2) are distinct, the two couples (v_1', S_1') and (v_2', S_2') are distinct, and the sum $\kappa+\kappa'+k$ is odd. The amplitudes of the double tensors are chosen so that the constant of proportionality is equal to the ratio of two 3-j symbols, multiplied by a phase factor. An explicit expression for this factor is given for f electrons, and a number of applications are discussed. (auth)

22773 AN APPROACH TO GRAVITATIONAL RADIATION BY A METHOD OF SPIN COEFFICIENTS. Ezra Newman (Univ. of Pittsburgh) and Roger Penrose. J. Math. Phys., 3: 566-78(May-June 1962).

An approach to general relativity by means of a tetrad or spinor formalism is presented. The essential feature of this approach is the consistent use of certain complex linear combinations of Ricci rotation coefficients, which in effect give the spinor affine connection. The formalism is applied to two problems in radiation theory, namely a concise proof of a theorem of Goldberg and Sachs and a description of the asymptotic behavior of the Riemann tensor and metric tensor, for outgoing gravitational radiation. (auth)

22774 THE SOLUTION OF A TRANSITION PROBLEM IN A SUPERCONDUCTING STRIP. Werner Liniger (International Business Machines Corp., Yorktown Heights, N. Y.). J. Math. Phys., 3: 578-86(May-June 1962).

The isothermal transition of a strip of superconducting material from the superconducting state to the normal state, under the influence of a supercritical external magnetic field, is studied on the basis of the London theory of superconductivity. The problem can be formulated as a free boundary problem with parabolic differential equations, which is solved mainly by numerical methods; an analytical solution in the form of series expansions is given for the early part of the transition. It is found that, in the beginning, the transition in the strip behaves almost like the transition in a half-space. However, the two differ quite drastically as the transition nears completion. It is pointed out that predictions of the total transition time for the strip by extrapolating from the analytical solution for the half-space are incorrect. The results show that such estimates for the transition time are much too small. (auth)

22775 KINETIC TEMPERATURE MEASUREMENT. M. Fournet. J. phys. radium, 23: Suppl. No. 3, 25A-32A (Mar. 1962). (In French)

The proposed method allows the measurement of high gas temperature in fast transient phenomena such as those encountered in shock tubes used in aerodynamics, plasma studies, etc. The gas molecules' velocity spectrum is obtained by measurement of their time of flight in vacuum. The transit chamber is separated from the hot gas by a diaphragm, whose sudden bursting releases a jet of particles and enables the time origin to be defined. The molecules reach a detector at the end of their flight. The start of the response signal of this detector depends only on the temperature. A theoretical account is given of the method. Experiments are described, showing the value of measurements made on ambient temperatures and explosion temperatures of a hydrogen-oxygen mixture. The instrument is used to measure the temperature produced by a capacitor discharging into a test resistance; the ejection speeds of the particles are between 20 and 50 km/sec, corresponding to an approximate temperature of 10^5 °K. (auth)

22776 OBTAINING HOMOGENEOUS MAGNETIC FIELDS. G. Raoult, J. Adamski, J. P. Cueille, C. Laval, and M. R. Roux (Laboratoire de Radioélectricité, Faculté des Sciences, Clermont-Ferrand, France). J. phys. radium, 23: Suppl. No. 3, 47A-51A(Mar. 1962). (In French)

Supposing that the magnetic lines of flux are perpendicular to the pole pieces, an electrolytic trough is used to study the pole shape, in order to obtain an optimum homogeneous field. With simple machining, it is possible to improve the homogeneity of the field by a factor of more than a hundred. (auth)

22777 VIBRATIONAL SPECTRUM AND SPECIFIC HEAT OF LITHIUM. M. P. Hemkar and S. K. Joshi (University, Allahabad, India). J. Phys. Soc. Japan, 17: 754-8 (May 1962). (In English)

The vibrational spectrum and specific heat of lithium are calculated using a three-force-constant model of monovalent metals. The calculations are made with two sets of elastic constants, one with those measured at 78°K and the other with calculated values at absolute zero. The calculated specific heat and Debye temperature are compared with the experimental data. It is found that the calculations based on the elastic data at 78°K give better agreement with experiment at higher temperatures while those from elastic constants at absolute zero agree better with experiment at lower temperatures. (auth)

22778 LANDAU LEVELS AND CYCLOTRON RESONANCE IN GRAPHITE. Masaharu Inoue (Tokyo Univ.). J. Phys. Soc. Japan, 17: 808-19(May 1962). (In English)

Landau levels and their eigenfunctions are calculated for the band model. Owing to the interband effect, the energy levels do not agree with semiclassical energy levels. The theory of cyclotron resonance absorption is developed on the basis of the calculated energy levels and eigenfunctions. An interpretation of cyclotron resonance experiments is presented. It is shown that the values of k_z that give absorption peaks are $k_z = 0$ for holes and $E_z = E_j$ for electrons. The values $\gamma_0^2/\gamma_1 = 31$ ev and $\gamma_3^2/E_f = 317$ ev are obtained for band parameters to fit the experimental data. The possibility of determining γ_1 directly from the magneto-optical effect is also discussed. (auth)

22779 NUCLEAR MULTI-RELAXATION AT LOW MAGNETIC FIELDS. Eizo Otsuka (Osaka City Univ.) and Stephen M. Day. J. Phys. Soc. Japan, 17: 885-6(May 1962).

A single crystal of KI is kept in a 6.3-kOe field that is parallel either to the [100] or [110] directions for a period of 24 hr. The field is then reduced to a low value (0 to 105 Oe) for a variable period up to 120 min, then increased again to 6.3 kOe, and the final/initial ratio of the magnetization signal intensities is measured. The relaxation of nuclear magnetization of I^{127} is thus found as a function of time, and is observed to take place in three steps. The first step is suggested to be caused by spin mixing between I and K, the second to be peculiar to nuclei having quadrupole electric moments, and the third to be caused by spin-lattice relaxation. (T.F.H.)

22780 OPTICAL PUMPING OF GASES. W. Barthold (Christian-Albrechts Universität, Kiel). Kerntechnik, 4: 185-8(May 8, 1962). (In German)

The method of optical pumping of gases is used for the measurement of spectra. A very high degree of accuracy is obtained, which exceeds by many times the accuracy obtained by customary methods. The possibility of an exact verification of the theory is given, and hyperfine splitting can be determined with extremely high accuracy. (auth)

22781 RADIOACTIVE SELF-LUMINOUS COMPOUNDS. III. TEMPERATURE DEPENDENCE OF LIGHT INTENSITY AND PHOTOLUMINESCENCE DECAY OF RADIOACTIVE SELF-LUMINOUS COMPOUNDS. Yasuro Atô and Ryôichiro Fujimura. Nagoya Kôgyô Gijutsu Shikensho Hôkoku, 10: 561-6(Sept. 1961).

The intensity of luminescence as a function of operating temperature and photoluminescence decay after excitation mainly by 3650 Å uv light were studied on radioactive self-luminous compounds which were mixtures of types of powder phosphors as ZnS, ZnS–CdS, and $ZnSiO_4$ with Sr^{90}–Y^{90} as the carbonate. The depths of the electron trap levels estimated from the light intensity vs temperature (–150 to 100°C) were between 0.3 to 0.7 ev. Only the decay constant and the decay rates of the phosphors were reduced slightly as a result of being mixed with the β-active isotope. The sensitivity for detection of the temperature difference was 1 to 2°C per minimum reading scale of detector by using cubic ZnS; [Zn]. (OID)

22782 NEUTRON CAPTURE IN TIN ISOTOPES AT STELLAR TEMPERATURES. R. L. Macklin, T. Inada, and J. H. Gibbons (Oak Ridge National Lab., Tenn.). Nature, 194: 1272(June 30, 1962).

Neutron capture cross sections were measured for seven tin isotopes (116 to 120, 122, and 124) with 30-kev neutrons. The abundances of the tin isotopes due to giant-star and supernovae nucleosynthesis are calculated, and the product of the abundance and cross section is approximately constant for all the isotopes, in agreement with the predicted inverse proportionality. The increased importance of the r-process (supernovae neutron capture) relative to the s-process (giant star neutron capture) is shown. (D.L.C.)

22783 A ROOM-TEMPERATURE DIFFUSION CONSTANT FOR HYDROGEN IN PROTON-IRRADIATED STEEL. David Tilles (Smithsonian Astrophysical Observatory and Harvard Coll. Observatory, Cambridge, Mass.). Nature, 194: 1273-4(June 30, 1962).

Mild steel samples, which were bombarded by 1-Bev protons for measurements of tritium and Ar^{37} production cross sections and then stored for 5 years, were used to study the retention of tritium. The results indicate a diffusion constant of 10^{-20} cm^2/sec for tritium, which probably is equal to the hydrogen constant within a factor of 2. However, the result differs from other recent measurements of the hydrogen constant in iron and steel by a factor of more than 10^3. Considerations to be taken into account when comparing the measurements are discussed. (D.L.C.)

22784 A BASIS FOR THE QUANTUM DEFECT METHOD. G. E. Norman. Optics and Spectroscopy (U.S.S.R.) (English Translation), 12: 183-5(Mar. 1962).

The quantum defect method proposed by Seaton cannot be considered rigorously proven. The application of the effective radius theory to a Coulomb attraction field is examined. Results permit substantiation of and improvements to the quantum defect method. (auth)

22785 MORIYA INTERACTION AND THE PROBLEM OF THE SPIN ARRANGEMENTS IN βMnS. Frederic Keffer (Univ. of Pittsburgh). Phys. Rev., 126: 896-900(May 1, 1962).

A study of the anisotropic superexchange interaction of the form $D_{ij} \cdot S_i \times S_j$ is made. This interaction is permitted in βMnS, with symmetry requiring that D_{ij} be normal to the plane defined by i, j, and the single intervening anion. It is conjectured that this interaction leads to a screw spin arrangement, with a 90° screw angle; in crystals considered heretofore the Moriya energy produces only a slight canting. The observed powder neutron diffraction pattern was interpreted as indicating ordering of the third kind with spins normal to the ordering axis; this arrangement, however, does not have minimum dipolar energy. The proposed arrangement leads to the same diffraction pattern, and the Moriya energy probably overbalances the dipolar. (auth)

22786 ANISOTROPIC SUPEREXCHANGE IN βMnS. J. J. Pearson (Univ. of Pittsburgh). Phys. Rev., 126: 901-11(May 1, 1962).

The suggestion by Keffer of an anisotropic superexchange of the Moriya type in βMnS led to the calculation. Whereas Moriya's work was confined to ions with one electron in the 3d shell and to cases of low symmetry, this calculation was performed for a half-filled 3d shell and tetrahedral symmetry. The unperturbed state was taken to consist of two Mn^{2+} ions together with their common S^{2-} nearest neighbor, each in a tetrahedral crystal field. The perturbing Hamiltonian contained the electronic spin-orbit interaction and the Coulomb interaction between electrons on neighboring ions. The mechanism involved going from the ground state to an excited crystal field state on one Mn^{2+} ion by the spin-orbit effect, then back to the ground state by superexchange between the Mn's. The direction of the D vector was perpendicular to the plane of the three ions, and its magnitude was of the order of a superexchange integral times the spin-orbit parameter over a crystal field split-

ting energy. The existence of the effect depends upon π overlap between the Mn and S orbitals. (auth)

22787 ELECTRICAL AND THERMAL RESISTIVITIES AND THE FERMI SURFACE OF MONOVALENT METALS. S. K. Joshi and B. M. S. Kashyap (Allahabad Univ., India). Phys. Rev., 126: 936-8(May 1, 1962).

Crude information about the nature of the Fermi surface in alkalis and noble metals is derived from the ratio of low-temperature electrical and thermal resistivities. The values of the characteristic temperatures occurring in electrical and thermal resistivities are evaluated using Houston's method. Inferences regarding the Fermi surface are consistent with refined measurements. (auth)

22788 TUNNELING INTO SUPERCONDUCTORS AT TEMPERATURES BELOW 1°K. I. Giaever, H. R. Hart, Jr., and K. Megerle (General Electric Research Lab., Schenectady, N. Y.). Phys. Rev., 126: 941-8(May 1, 1962).

The density of states in Pb, Sn, In, and Al, was studied using the tunneling technique. Results agree with the Bardeen-Cooper-Schrieffer theory; two exceptions were found. The energy gap is not as sharp in the experiment as in the theory, but this may merely be due to imperfect samples. The density of states in Pb has definite but small divergences from the theory. (auth)

22789 METASTABLE HYDROGEN MOLECULES. II. FINE STRUCTURE OF PARAHYDROGEN. William Lichten (Univ. of Chicago). Phys. Rev., 126: 1020-7(May 1, 1962).

The fine structure of the N = 2 rotational level of the $(1s_g, 1s_u)c^3\pi_u$ state of parahydrogen, probably in the v = 0 vibrational level, was measured directly by the molecular beam magnetic resonance method. The zero field intervals are: f(J = 2 ↔ J = 1) = 4928.003 ± 0.010 Mc/sec, f(J = 3 ↔ J = 2) = 5898.105 ± 0.012 Mc/sec. The spin-spin and spin-orbit interaction constants agree with theoretical predictions based on a simplified hydrogenic model. (auth)

22790 NUCLEAR MAGNETIC RELAXATION OF A THREE-SPIN ASYMMETRIC MOLECULE IN A LIQUID. G. W. Kattawar and M. Eisner (Texas Agricultural and Mechanical Coll., College Station). Phys. Rev., 126: 1054-6(May 1, 1962).

The semiclassical density-matrix theory of relaxation is employed to calculate the relaxation of the z component of nuclear magnetization of molecules in a liquid for the case in which three identical nuclei of spin ½ are arranged at the vertices of an isosceles triangle whose angles are 30, 30, and 120°. If the initial state of the spin systems is characterized by a spin temperature, the relaxation consists of the sum of seven terms which decay exponentially with different time constants. Even though the z component of the magnetization is a function of seven distinct time constants, a plot of $\ln(M_z - M_{eq})$ can be approximated by a single straight line for regions of experimental interest. The time constant for this straight line differs less than 1% from the average relaxation time calculated from the formulas of Gutowsky and Woessner. (auth)

22791 FINE STRUCTURE OF THE $2\ ^3P$ AND $3\ ^3P$ STATES OF HELIUM. C. L. Pekeris, B. Schiff, and H. Lifson (Weizmann Inst., Rehovoth, Israel). Phys. Rev., 126: 1057-8(May 1, 1962).

Using an extension of the method of Pekeris for S states, eigenvalues and eigenfunctions were obtained for the $2\ P^1$, $2\ P^3$, $3\ P^1$, and $3\ P^3$ states of helium. The fine-structure splittings of the $2\ P^3$ and $3\ P^3$ states were computed, including the α^3 quantum electrodynamic correction and the singlet-triplet correction. Determinants up to order n = 220 were solved, and when the results were extrapolated to n → ∞ good agreement was obtained with recent accurate measurements of the fine-structure splittings, substantiating the correctness of the α^3 terms. (auth)

22792 NEW CLASS OF CLASSICAL UNCERTAINTY RELATIONS GIVING UNCERTAINTY FOR LONG AND CERTAINTY FOR SHORT TIMES. Eugene Guth (Oak Ridge National Lab., Tenn.). Phys. Rev., 126: 1213-15(May 1, 1962).

Bohr's concept of complementarity enters any statistical description of physical phenomena. In quantum theory, the complementary quantities are dynamical variables. In classical theory, complementarity exists between dynamical and statistical variables. Slowing down of a "large" particle of mass m by multiple collisions with a gas of "small" molecules leads to certainty for "short times." For "long times," the multiple collisions introduce statistics leading to uncertainty. An uncertainty relation was derived for the coordinate q as the dynamical and the drift momentum p_d as the statistical complementary variable: $\Delta p_d \Delta q \geq mD(1 - e^{-t/\tau})$, where D is a diffusion coefficient and τ a relaxation time. This relation gives uncertainty for "long," and certainty for "short" times. The existence of such a classical uncertainty relation poses the question of whether a generalization of (relativistic) quantum theory is possible, such that for "high energies" $\Delta p \Delta q \to 0$, while for low energies $\Delta p \Delta q \geq \hbar/2$. This question is not answered; it is pointed out that the telegrapher's equation (which classically implies the generalized uncertainty principle) with $\tau = \hbar/2mc^2$ is satisfied by the Klein-Gordon (also Dirac) wave function for a free particle if the time dependence of the rest mass is split off from it. (auth)

22793 ASYMPTOTIC PROPERTIES OF A SYSTEM WITH NONZERO TOTAL MASS. Peter G. Bergmann, Ivor Robinson, and Engelbert Schuecking (Syracuse Univ., N. Y.). Phys. Rev., 126: 1227-31(May 1, 1962).

When certain geometrical figures, which in a flat space would be closed, such as parallelograms of geodesics, are constructed far from the massive source of a gravitational field, they will fail to close in the Riemann-Einstein manifold considered. If, on removing such a figure to infinity it is scaled proportionally to its distance from the source, the size of the gap will have an asymptotic value of the order of the Schwarzschild radius of the massive source. Accordingly, an asymptotically geodesic coordinate system cannot be constructed in the whole region far from the source, that will mesh properly everywhere at spatial infinity. Coordinate systems in use are not as nearly geodesic as would be compatible with the local curvature of the manifold. (auth)

22794 SELECTION OF POLE CONFIGURATION FOR QUADRUPOLE LENSES. V. K. Plotnikov (Inst. of Theoretical and Experimental Physics, Academy of Sciences, USSR). Pribory i Tekh. Ekspt., No. 2, 29-33 (Mar.-Apr. 1962). (In Russian)

The field non-linearity of quadrupole lenses was calculated. Lenses with hyperbolic and plane pole configurations were studied. (tr-auth)

22795 RAPIDLY RUNNING TRANSITIONS AT HIGH PRESSURE. Leason H. Adams and Briant L. Davis (Univ. of California, Los Angeles). Proc. Natl. Acad. Sci. U. S., 48: 982-90(June 1962).

With diamond and beryllium pistons, operating on the "squeezer" principle, x-ray-diffraction patterns were obtained for AgI, RbI, NH_4I, RbCl, and Ce at pressures above and below the transition pressures. The recorded angles were used to derive the parameters of the high-pressure

forms. The transitions, either from low pressure to high pressure or vice versa, were found to take place very rapidly, the bulk of the changes occurring in a few seconds. (D.L.C.)

22796 MAGNETOHYDRODYNAMIC WAVES IN A CONSTANT DIPOLE MAGNETIC FIELD. John Carstoiu (Science for Industry, Inc., Brookline, Mass.). Proc. Natl. Acad. Sci. U. S., 48: 990-6(June 1962).

The magnetohydrodynamic behavior of an electrically conducting fluid in a constant dipole magnetic field is investigated in terms of generalized Alfvén waves by means of vorticity and current density. The resulting equations are complicated, and solutions are discussed for large distances from the center of the dipole. The geometry of lines of force is discussed briefly. (D.L.C.)

22797 THE GRAVITATIONAL INSTABILITY OF A NON-UNIFORMLY ROTATING, HOMOGENEOUS AND HEAT CONDUCTING MEDIUM. S. P. S. Anand and R. S. Kushwaha (Univ. of Delhi). Proc. Phys. Soc. (London), 79: 1089-92(June 1, 1962).

The gravitational instability of a non-uniformly rotating, infinite, axisymmetric cylinder of a homogeneous, heat conducting medium is discussed. The Bel and Schatzman criterion of gravitational instability remains unaffected, even when the medium is heat conducting. (auth)

22798 PRESSURE-INDUCED ARC TRANSITION AND OPTICAL QUENCHING. A. Von Engel and K. W. Arnold (Univ. of Oxford). Proc. Phys. Soc. (London), 79: 1098-1104(June 1, 1962).

When the pressure of a molecular gas surrounding a carbon arc is reduced below a certain value, a sudden contraction of the cathode spot is observed. This is interpreted as a change from the thermionic to the vapor cathode arc. A transition mechanism is suggested; on decreasing the molecular concentration of the ambient gas, optical quenching is reduced, and a decreasing number of molecules remove potential energy from excited-vapor atoms. Hence, an increasing number of excited atoms are available which transfer their potential energy to the electrons in the cathode substance, thereby releasing electrons from the cathode so that a vapor cathode spot is formed. A numerical estimate of the required quenching cross section (order 10^{-15} cm^2) shows accord with values found in optical quenching experiments. Implications in regard to tungsten, mercury, and copper cathodes are discussed. (auth)

22799 THE IMPACT PARAMETER METHOD FOR ELECTRON EXCITATION OF OPTICALLY ALLOWED ATOMIC TRANSITIONS. M. J. Seaton (University Coll., London). Proc. Phys. Soc. (London), 79: 1105-17(June 1, 1962).

The semi-classical impact parameter method gives transition proabilities $P_{ji}(R)$ which, for impact parameters R large compared with the atomic radius, are proportional to the oscillator strengths f_{ji}. When modified such that reciprocity conditions are satisfied, the results agree with quantal calculations, even for near-threshold energies. When the coupling is weak, $Q(i \rightarrow j) = \int_{R_0}^{\infty} P_{ij}(R) 2\pi R dR$, where $R_0 \simeq \bar{r}_<$, the smaller of the mean radii $\bar{r}_i$, $\bar{r}_j$, and when the coupling is strong, $Q(i \rightarrow j) = \frac{1}{2}\pi R_1^2 + \int_{R_1}^{\infty} P_{ji}(R) 2\pi R dR$, where $P_{ji}(R_1) = \frac{1}{2}$. The smaller of the cross sections is adopted. The method agrees with experiment for H 1s → 2p, He 1s → 3p, and Na 3s → 3p. It is superior to the Born approximation, which overestimates the low-energy contribution from small impact parameters. Cross sections are calculated for transitions between excited states of hydrogen. (auth)

22800 CHARGE TRANSFER REACTIONS OF DOUBLY CHARGED IONS. M. Islam, J. B. Hasted, H. B. Gilbody, and J. V. Ireland (University Coll., London). Proc. Phys. Soc. (London), 79: 1118-23(June 1, 1962).

Measurements are reported for total-charge-transfer cross sections for Ne, Ar, Kr, Xe doubly-charged ions in their own gas. They are for the processes $_{20}\sigma_{02} + (^1/_2)_{20}\sigma_{01}$. Comparisons are made with experiments and with the quantum theory calculations of Fetisov and Firsov. (auth)

22801 ON THE RELATION BETWEEN PHASE SHIFT AND QUANTUM DEFECT. B. L. Moiseiwitsch (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 79: 1166-9 (June 1, 1962).

The effective range theory for the elastic scattering of electrons by a potential behaving asymptotically like a Coulomb field is employed to derive an exact relation between the phase shift and the quantum defect. For zero energy electrons, this relation reduces to the formula of Seaton. (auth)

22802 MAGNETOHYDRODYNAMIC CONVERSION. Quaderni studi e notiz. (Milan), 17: 165-72(Mar. 1961). (In Italian)

The principle of magnetohydrodynamic conversion is discussed, and the design of this type generator is described. The practical problems, present realizations, and future prospects of magnetohydrodynamic generators are reviewed in conclusion. (J.S.R.)

22803 ENERGY DISSIPATION IN FINITE CAVITIES. D. E. Charlton and D. V. Cormack (Univ. of Saskatchewan, Can.). Radiation Research, 17: 34-49(July 1962).

A method of calculating the distribution of the energy dissipated by electrons near an interface and across a parallel slab or cylindrical cavity has been developed. The results are presented in such a form as to reduce greatly the amount of labor required for such calculations. (auth)

22804 OBSERVABLES IN GENERAL RELATIVITY. Peter G. Bergmann (Syracuse Univ., N. Y.). Revs. Modern Phys., 33: 510-14(Oct. 1961).

Assuming the validity of the principle of covariance, the concept of observables is discussed, and the construction of observables is explained. A comparison of general covariance versus Lorentz covariance is presented. Discrepancies in the concept of general covariance are discussed. (L.N.N.)

22805 LIE GROUP DYNAMICAL FORMALISM AND THE RELATION BETWEEN QUANTUM MECHANICS AND CLASSICAL MECHANICS. Thomas F. Jordan and E. C. G. Sudarshan (Univ. of Rochester, N. Y.). Revs. Modern Phys., 33: 515-24(Oct. 1961).

General structural features of dynamical theories can be exhibited in relations between classical and quantum mechanics; the essential structure is a Lie algebra of basic dynamical-variable functions providing transformation-group infinitesimal generators. It is shown that the particular representation chosen is not important for the dynamical structure analysis by considering possibilities of transcribing classical and quantum mechanics each into the natural representation of the other. This leads to an outlining of the formal theory of generalized dynamics by constructing a class of Lie algebras including those of classical and quantum mechanics as special cases. (L.N.N.)

22806 ATOMIC SCATTERING PROCESSES. E. Gerjuoy (E. H. Plesset Associates, Inc., Los Angeles). Revs. Modern Phys., 33: 544-53(Oct. 1961).

Atomic reaction measurements and calculations are surveyed. Electron elastic scattering by [illegible]toms, slow heavy-particle reactions, fast reactions, exc[illegible]tion transfer, and threshold behavior are discussed. Fairly suc-

cessful calculations exist for most processes; most data include some deviations from theory. Other conflicts exist because of the necessary approximations in calculations. (L.N.N.)

22807 SECONDARY ELECTRON EMISSION FROM IODINE. É. G. Martisinovskaya, T. L. Matskevich, and G. M. Rubanova (Ioffe Inst. of Physics and Tech., Leningrad). Soviet Phys.-Solid State, 3: 2641-2(June 1962).

Data are obtained concerning the dependence of σ and η, the secondary electron emission and inelastic reflection coefficients respectively for iodine, on the primary electron energy (u_p) from 200 to 3000 ev. The $\sigma(u_p)$ dependence has a very flat maximum, the maximum value of σ being 1.4. The depths from which slow secondary electrons are emitted for u_p = 500, 1000, and 3000 ev are experimentally determined as 570, 840, and 1100 Å respectively. (auth)

22808 THERMOMAGNETIC PHENOMENA IN SEMICONDUCTORS IN A STRONG MAGNETIC FIELD FOR THE CASE OF ELECTRON SCATTERING BY A SHORT-RANGE POTENTIAL. A. I. Ansel'm and B. M. Askerov (Semiconductor Inst., Leningrad and Physics Inst., Academy of Sciences, AzerSSR, Baku). Soviet Phys.-Solid State, 3: 2685-70(June 1962).

Using the Onsager principle and the density matrix method, thermomagnetic phenomena are studied in a strong quantizing magnetic field. For a short-range scattering potential the dependence of the thermal emf and the Nernst constant on magnetic field and temperature is obtained in the quantum limit. (auth)

22809 λ-POINT OF CONCENTRATED He^3–He^4 SOLUTIONS. B. N. Eselson, V. G. Ivantsov, and A. D. Shvets (Inst. of Physics and Technology, Academy of Sciences, Ukr. S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 42: 944-8 (Apr. 1962). (In Russian)

The transition temperatures in He isotope solutions containing 50.0, 59.6, and 62.4% He^3 are measured, and found to be 1.31, 1.05, and 1.02°K respectively. No λ-transition is detected in a solution with 66.1% He^3. (auth)

22810 EFFECTIVE CROSS SECTION FOR PHOTOIONIZATION OF LITHIUM IONS. V. A. Zhirnov. Zhur. Eksptl'. i Teoret. Fiz., 42: 1097-1102(Apr. 1962). (In Russian)

The cross section for photoionization of the Li^+ ion in the ground state is calculated in the Coulomb-interaction approximation. An approximate quantum mechanical calculation of the Li^- photoionization cross section is carried out by taking into account the binding energy of 0.80 ev. (auth)

22811 SPIN-SPIN INTERACTION VIA A PHONON FIELD IN PARAMAGNETIC CRYSTALS. L. K. Aminov and B. I. Kochelayev (Kazan Univ., U.S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1303-6(May 1962). (In Russian)

Spin coupling via a phonon field is considered by quantum field theory methods. The energy of paired spin interaction is written down in operator form for cases when retardation can be neglected. The effect of this interaction on the shape of the resonance lines is estimated. (auth)

22812 RECOMBINATION OF ELECTRONS IN A MONOATOMIC GAS. L. P. Pitaevskii (Inst. of Problems in Physics, Academy of Sciences, U.S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1326-9(May 1962). (In Russian)

The coefficient for recombination of electrons with ions during triple collisions of the electron and ion with the gas atoms is calculated with the Fokker–Planck equation. (auth)

22813 SOME FEATURES OF THE EQUILIBRIUM DIAGRAM FOR A He^3–He^4 SOLUTION AT THE λ-POINT. D. G. Sanikidze. Zhur. Eksptl'. i Teoret. Fiz., 42: 1330-2(May 1962). (In Russian)

The nature of the singularities in the equilibrium diagram of an He^3–He^4 solution at the λ point is investigated. (auth)

22814 ON THE DETONATION AND BURNING IN MAGNETIC HYDRODYNAMICS. V. P. Demutskii (Khar'kov State Univ.). Zhur. Tekh. Fiz., 32: 445-9(Apr. 1962). (In Russian)

Detonation and combustion are studied in magnetohydrodynamic media in a closed tube. The shock magnitudes on detonation and combustion waves are evaluated at high energies, and the types of automodel and shock waves following detonation and combustion are examined. (R.V.J.)

22815 THE SENSE OF A MOLECULAR BEAM FORMED BY THE OUTFLOW OF A GAS FROM THE CHANNEL. V. S. Troitskii (Gor'kii State Univ.). Zhur. Tekh. Fiz., 32: 488-502(Apr. 1962). (In Russian)

A kinetic theory of molecular beam formation in vacuum was developed, and calculations are made of the direction and intensity of a beam in the vacuum formed by an outflow of gas in a channel. The theoretical diagram and regularities of beam formation developed for a rectangular channel are in good agreement with experiments. (R.V.J.)

22816 DISTRIBUTION FUNCTION OF DISPLACED ATOMS PRODUCED IN A SOLID BY IRRADIATION. A. Corciovei, Gr. Ghika, and D. Grecu (Institutal de Fizică Atomică, Academia R. P. R., Bucharest). IAEA Preprint SM-25/8. 32p. (In French)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials held in Venice, Italy, 7-11 May 1962.

The spatial distribution of displaced atoms produced by a primary atom of given initial energy and direction is studied. One calculates the mean values of various products of the components of final position of the primary atom. The theoretical task is accomplished in the hard core approximation for the interaction between atoms. The correlated distribution function, introduced by Holmes and Leibfried, is generalized by taking into account the possibility of stopping the primary atom when its energy has diminished below a given energy, about 25 ev. Recurrence formulas were found which connect the mean values of the components in the n displacement with the corresponding quantities in the (n-1) displacement. Further, it is possible to establish some integral equations which give the desired mean values. With the aid of these quantities one obtains the distribution function of the displaced atoms, which in the second approximation is a three-dimensional gaussian function with ellipsoidal symmetry. In the third approximation the distribution function differs to a small extent from the gaussian function. (auth)

22817 THE USE OF MONTE CARLO CALCULATIONS IN THE ANALYSIS OF RADIATION DAMAGE EXPERIMENTS. S. Wright (Atomic Energy Research Establishment, Harwell, Berks, Eng.). IAEA Preprint SM-25/57. 17p. (In English)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials held in Venice, Italy, 7-11 May 1962.

The need for neutron energy spectra in the Mev range for the analysis of radiation damage experiments and the application of results obtained in research reactors to situations of practical interest are discussed. Results of a Monte Carlo program designed to calculate neutron spectra

in the range 10 kev to 14 Mev are presented for some experimental positions in heterogeneous research reactor systems, and for the graphite in a power reactor. These spectra are compared with experiment by comparing the calculated reaction rates of some threshold detectors with the reaction rates observed in the reactors. The Kinchin and Pease model for the number of displaced atoms resulting from a fast neutron collision is described briefly and is used to calculate the damage rates in the calculated spectra, and it is shown how radiation damage experiments in two differing spectra can be used to determine the importance of energy loss by electronic excitation. The resulting damage function can then be used to relate the results of accelerated tests in research reactors to power reactors. (auth)

Astrophysics and Cosmology

22818 ABSORPTION BY INTERGALACTIC HYDROGEN. George B. Field (Princeton Univ., N. J.). Astrophys. J., 135: 684-93(May 1962).

Fluxes of Cygnus A relative to those of Cassiopeia A were determined at 1265 to 1500 Mc for detecting absorption by intergalactic neutral hydrogen. The rms deviation of individual flux ratios from a least-squares line is 0.82%, including an apparent 50-Mc oscillation in the data, probably due to an unexplained instrumental effect. The opacity due to intergalactic hydrogen is less than 0.25%, 1/3 of the upper limit found in an earlier experiment. If this value is accepted, either the intergalactic medium is hotter than 10^4 °K (and presumably ionized), or it is cooler (but ionized more than 42%), or its density is less than 10^{-29} gm cm^{-3}. The latter value is inadequate by a factor of 2 to account for a deceleration parameter of unity. (auth)

22819 IONIZED GAS IN SPIRAL AND IRREGULAR GALAXIES. E. Margaret Burbidge and G. R. Burbidge (Univ. of Chicago and Univ. of Texas). Astrophys. J., 135: 694-710(May 1962).

The distribution of ionized gas as deduced from the emission lines seen using the nebular spectrograph is described for more than 30 spiral and irregular galaxies. From the comparison of estimates of the relative intensities of Hα and [N$_{II}$] λ 6583, with relative intensities computed by the usual techniques, it is concluded that the major regions of emission in the outer parts of galaxies and in the spiral arms, where the Hα/[N$_{II}$] λ 6583 ratio is ~3, are similar to the extended H$_{II}$ regions in this galaxy. The investigation has substantiated the result that irregular galaxies have the highest proportion of ionized gas and that this decreases steadily through barred spirals of types SBc and SBb and normal spirals of types Sc, Sbc, Sb, and Sa. Throughout irregular galaxies and in the nuclear, as well as the spiral-arm, regions of SBc and SBb galaxies and some Sbc and Sc galaxies, there must be a considerable population of massive luminous stars. The nuclei of other Sc and Sbc galaxies and the nuclei in the majority of Sb galaxies contain less ionized gas than do the spiral-arm regions. The most striking observational result is that between the outer parts and the nuclear regions in many of the latter galaxies, the ratio of the strengths of Hα and [N$_{II}$] λ 6583 decreases from about 3 to ~1 to 0.1. This reversal is most common in Sb and Sa galaxies having large prominent nuclei and well-developed nuclear bulges, but it appears in Sc galaxies having small nuclei. This can be explained either by a general deficiency of hydrogen in these regions or by supposing that radiative processes are comparatively unimportant in those nuclei where the light comes mainly from K giants, and that collisional ionization and excitation take place in the gas at an electron temperature of 20000 to 40000°, or having energies of a few electron volts, since such excitation may be non-thermal. These excitation conditions might arise through corpuscular radiation from stars. Whether such an explanation for the anomalous ratios is accepted depends on estimates of the energy supply required to maintain such a high electron temperature against cooling mainly by line emission. This requires absolute measurement of emission-line intensities. (auth)

22820 INTERSTELLAR GAS NEAR THE SUN. G. Muench and A. Usnoeld (Carnegie Inst., Washington, D. C.; California Inst. of Tech., Pasadena; and Universität, Kiel). Astrophys. J., 135: 711-14(May 1962).

Observations of interstellar Ca$_{II}$ lines in the spectrum of α Oph and other stars in the same area of the sky are reported. From the radial velocities and intensities of the interstellar lines, it is shown that the cloud in front of α Oph has linear dimensions of the order of 1 pc and a total number density of order unity. (auth)

22821 EFFECTIVE TEMPERATURES OF F-TYPE STARS USING Hγ LINE PROFILES. Leonard Searle and J. B. Oke (Carnegie Inst., Washington, D. C. and California Inst. of Tech., Pasadena). Astrophys. J., 135: 790-801 (May 1962).

Line profiles for the hydrogen line Hγ were computed for effective temperatures and gravities corresponding to those of F-type stars of different luminosity classes. These were compared with observed profiles for the cluster-type variables RR Lyrae and SU Draconis, two F-type subdwarfs, and the F-type stars with metal lines of normal strength-ν Herculis, η Aquilae, and δ Cephei. For the first two groups of stars, the metal lines are weak, and the continuum can be drawn unambiguously. The observed and computed profiles agree, and the line profiles can be used as reddening-independent temperature indicators. A comparison of these Hγ temperatures with those determined by fitting observed absolute energy distributions to fluxes computed from model atmospheres shows agreement, allowing interstellar reddening. For the third group of stars, which have strong metallic lines, the evidence is strong that no true continuum is observed. The depression of the continuum is small enough in ν Herculis (F2 II) that an estimate of the effective temperature can still be made by fitting the observed Hγ profile to those computed. At spectral types F5 or later, the continuum is depressed to such an extent that a temperature determination by Hγ fitting is not possible. (auth)

22822 CONVECTION ZONES IN STELLAR ATMOSPHERES. K. S. Krishna Swamy and R. S. Kushwaha (Univ. of Delhi). Astrophys. J., 135: 802-11(May 1962).

In following the evolution of stars to the cooler regions of giants in the H-R diagram, core solutions are fitted with the atmospheric solutions; this parameter is the constant that joins the pressure and temperature at the end of the ionization zone. The distribution of this parameter in the H-R diagram was studied by computing atmospheric models. The value of the constant of the adiabatic relation is less for main-sequence stars for the same spectral type. For the sun, the convection zone extends to about 30% of the solar radius. (auth)

22823 OBSERVATIONAL STUDY OF MACROSCOPIC INHOMOGENEITIES IN THE SOLAR ATMOSPHERE. I. VELOCITY DISPLACEMENTS OF FRAUNHOFER LINES AS A FUNCTION OF LINE STRENGTH AND POSITION ON DISK. J. W. Evans and R. Michard (Sacramento Peak Ob-

servatory, AFCRL and Observatoire, Paris). Astrophys. J., 135: 812-21(May 1962).

The "random turbulent velocities," ξ, of macroscopic motion in the solar atmosphere were directly observed at the center of the disk as local Doppler displacements in 18 lines, ranging in Rowland intensity from 0 to 1000 (K_2 line of Ca II). The measurements show a marked increase of ξ with line strength. On a given spectrogram, the correlation between the velocity shifts of one line with those of another line diminishes steadily as the intensity difference between the two lines increases. There is thus a quantitative and qualitative variation in the velocity field with height, as indicated by line strengths. The center-to-limb variations in ξ were determined for four lines with Rowland intensities from 0 to 20. The strong and faint lines behave differently. The very pronounced increases of ξ with line strength observed at the center of the disk disappears toward the limb. Here, within observational accuracy, ξ is the same for all line strengths in the observed range. The velocity field consists of a vertical component that increases strongly with height and a horizontal component independent of height. (auth)

22824 PLASMA DYNAMICS IN COMETS. I. PLASMA INSTABILITY. Fred Hoyle (Cambridge Univ., Eng.) and Martin Harwit. Astrophys. J., 135: 867-74(May 1962).

Biermann suggested that ionized gas clouds in comet tails are accelerated by collision with a stream of solar particles. The field-free case is discussed to establish conditions for which cometary plasma acceleration may be enhanced by plasma instability. A general criterion for instability of plasmas of arbitrary ionic composition and velocity distribution is derived. This result is applied to determine the stability of combinations of cometary gas densities and solar particle densities and temperatures. Electron-ion instability grows briefly if the solar electrons are cool enough. This is a transient effect. As soon as the electrons lose their translational velocity, their temperature becomes high enough to restore plasma stability, even for succeeding generations of inflowing electrons. The total momentum transfer is negligibly small compared with the momenta of cometary-tail ions. Plasma instability does not appreciably contribute to tail plasma acceleration. (auth)

22825 PLASMA DYNAMICS IN COMETS. II. INFLUENCE OF MAGNETIC FIELDS. Martin Harwit and Fred Hoyle (Cambridge Univ., Eng.). Astrophys. J., 135: 875-82(May 1962).

A mechanism consistent with the theory that tail ions are accelerated through interaction with streams of solar particles is sought. If predominantly transverse magnetic fields are imbedded in the solar stream, the observed accelerations can be imparted to tail ions. The ~10 km sec^{-1} observed ejection velocities from comet heads and the filamentary structure of many comet features are discussed. Observational tests for the transverse field hypothesis are suggested. (auth)

22826 THE EFFECT OF NEUTRINO EMISSION ON ELEMENT ABUNDANCES IN STARS. Richard Stothers and Hong-Yee Chiu (Inst. for Space Studies, New York). Astrophys. J., 135: 963-5(May 1962)

Characteristic evolution times and corresponding neutrino luminosity for a typical star of central density $\rho = 2 \times 10^6$ gm cm^{-3} are considered. The process $e^- + e^+ \rightarrow \nu + \bar{\nu}$, the most important ν-emission process, is discussed. At $T \gtrsim 0.5 \times 10^9$ sec, the ν luminosity is $\sim 10^3$ that of the sun and the time scale τ_ν is $\sim 10^7$ years. This is about the optical luminosity of the more luminous stars. At T ~0.6 to 1.0 B°K, the luminosity is about 10^6 that of the sun, and $\tau_\nu \sim 10^4$ years. (L.N.N.)

22827 MULTIPLE FORMATION OF NUCLEON PAIRS AND SUPERNOVAE EXPLOSIONS. D. A. Frank-Kamenetskii. Doklady Akad. Nauk S.S.S.R., 143: 78-80(Mar. 1, 1962). (In Russian)

The formation of nucleon pairs from π^0 mesons is considered in strong gravitational fields: $m\pi^0 \rightleftharpoons N + N$ (1). An expression for the equilibrium formation of nucleon pairs in an ideal neutron gas is presented. Then it is assumed that a sphere of radius R containing a mass of 1 [illegible] ss units of the sun goes into a state of unlimited condensation of matter (creation of very high gravitational fields). The relative number of nucleon pairs at low concentration is found to be: $\mathfrak{N}/n = 0.22\ \beta^3\ M^4\ \xi^3 \exp[(A - 4\xi)/\beta]$. Here β is the thermalization coefficient, ξ is a compression factor, and A varies from 3 at the center of the sphere to 2 at its surface. This sphere corresponds to the nucleus of a burned-out star. This formula shows that the concentration of nucleon pairs is very small for a single mass unit of the sun, but is very high for 10 mass units of the sun. Material consisting of nucleon pairs which are stabilized by gravity and high temperature can be considered as a diverse plasma of charged particles called an epigravitational plasma. Supernovae of type I can occur at about 1.5 mass units of the sun. In this case the concentration of nucleon pairs is low, the loss of energy by annihilation is low, and the residual star is an unstable red dwarf. With 10 mass units of the sun, supernovae of type II can occur, where the energy losses by annihilation processes is high. In this case the residual star contains anti-matter, and the capture of galactic matter leads to the emission of relativistic particles. (TTT)

22828 ON THE THEORY OF HYPERON STAR MASS CONFIGURATIONS. G. S. Saakyan and D. M. Sedrakyan (Erevan State Univ., Armenian SSR). Izvest. Akad. Nauk Armyan. S.S.R., Ser. Fiz.-Mat. Nauk, 14: No. 5, 109-14 (1961). (In Russian)

Previously it was shown that hyperon stars consist of three parts: hypernuclei, neutron layers, and external shells. The star mass is formed by hypernucleic and neutron layers; the external shell does not contribute to the mass. The radius of the hypernucleus exceeds the thickness of the neutron layer and the neutron layer is thicker than the external shell. The dimensions and mass of hyperstar configuration are calculated. (R.V.J.)

22829 EQUATIONS FOR THE SUPER DENSITY STATES. I. ASYMPTOTIC EQUATION OF STATE. G. S. Saakyan (Erevan State Univ., Armenian SSR). Izvest. Akad. Nauk Armyan. S.S.R., Ser. Fiz.-Mat. Nauk, 14: No. 6, 117-23(1961). (In Russian)

Calculations of hyperon configurations of stars demand an equation describing matter at energy densities exceeding densities in atomic nuclei. In the asymptotic equation developed by Ya. B. Zel'dovich the accepted equation $P = \rho/3$ is changed to $P(n) \approx \rho(n) \sim n^2$ (where n is the particle density, P is the pressure, and ρ is the energy density). An attempt is made to show that the accepted law of $P/\rho < 1/3$ is upset at any interaction where the energy of interacting particles exceed their kinetic energy and that the Zel'dovich equation is not related to a particular interaction on the meson field but is based on certain general principles in physics (the uncertainty principle and the fact that the velocity of sound should not exceed the velocity of light). (R.V.J.)

22830 MEASUREMENTS OF ELECTRON DIFFUSION COEFFICIENT IN NEUTRAL MOLECULES BY MEANS OF METEORITE RADIOLOCATION. E. I. Fialko (Tomsk Polytechnic Inst., USSR). Izvest. Vysshikh Ucheb. Zavedenii, Fiz., No. 2, 51-5(1962). (In Russian)

An indirect method, based on meteor-radio-echo time distribution, is suggested for measuring the coefficient of electron diffusion in neutral molecules in the ionosphere. The diffusion coefficient for an intense meteor ionization lead is $\approx 4 \times 10^{-15}$ cm^3/sec. (tr-auth)

22831 BETA DECAY IN STELLAR INTERIORS. John N. Bahcall (Indiana Univ., Bloomington). Phys. Rev., 126: 1143-9(May 1, 1962).

A study is made of the temperature and density dependence of beta-decay rates as affected by electron capture from continuum orbits, the absence of atomic binding energies, screening, and the exclusion principle. The rate of allowed electron capture from continuum orbits in a Fermi gas is calculated using the V-A law; Coulomb corrections are included. Nuclear matrix elements occur as parameters that can frequently be determined from terrestrial experiments. There is no atomic binding-energy contribution to the total beta-decay energy for completely ionized atoms; this causes a decrease in decay rates for low-energy electron emitters in stars relative to their terrestrial values. Screening usually will not affect beta-decay rates significantly. The exclusion principle inhibits beta decay in stellar interiors; many of the low-momentum states are occupied prior to the decay; the amount by which a decay rate is decreased can be calculated in terms of the known beta spectrum and the temperature and density of the medium surrounding the radioactive nucleus. Beta decay for normally radioactive nuclei is almost impossible in the interior of very dense stars, such as white dwarfs, since the Fermi energy can equal or exceed the maximum beta-decay energy available. Applications to the theory of element formation in stars are suggested. (auth)

Cosmic Radiation

22832 (AFCRL-862) INVESTIGATION OF THE HEAVY COMPONENT OF THE PRIMARY COSMIC RADIATION. Final Report. L. Witten and H. Hanson (RIAS. Div. of Martin Co., Baltimore). June 1961. Contract AF 19(604)-3868. 182p. (AD-265299)

Two detectors were built and flown by balloons which can detect relativistic heavy charged particles and discriminate charges over a range from $Z = 4$ to $Z \geq 30$. The detectors are argon-filled, double ionization chambers whose two halves are separated by a beryllium absorber. Relativistic charged particles will be little affected by the absorber and if they pass through equal lengths of the two chambers will produce pulses of equal heights. Nonrelativistic particles will produce pulses of unequal heights. Hence the pulses caused by relativistic charged particles can be electronically singled out by obvious coincidence and difference techniques. The charge of the particle can then be determined from a measure of the pulse height. Such a system lends itself immediately to two functions. Kept aloft in a balloon for a period of days, it can measure the particle spectrum and diurnal variation of the flux of primary heavy cosmic radiation. In a satellite it can operate even in the intense radiation belts surrounding the earth. Several short (6 to 12 hour) balloon flights were made which showed the successful operation of the equipment. (auth)

22833 DENSITY SPECTRUM OF EXTENSIVE AIR SHOWERS MEASURED UNDER MODERATE AND LARGE THICKNESSES OF LEAD. T. Sándor and A. Somogyi (Central Research Inst. of Physics, Hungarian Academy of Sciences, Budapest). Acta Phys. Acad. Sci. Hung., 14: 39-44(1962). (In English)

Density spectrum measurements are extended. The exponent $\gamma(\Theta)$ of the density spectrum of extensive air showers was measured under lead absorbers of various thicknesses; Θ varied between 0 and 20 cm Pb. $\gamma(\Theta)$ showed a definite minimum at about 2.5 cm of lead. Under $\Theta \approx 5$ cm of lead, $\gamma(\Theta)$ became approximately equal to $\gamma(0)$, and under $\Theta = 20$ cm of lead, it was slightly bigger than $\gamma(0)$. (auth)

22834 A STATISTICAL ANALYSIS OF THE BAROMETER COEFFICIENTS FOR COSMIC-RAY INTENSITIES. S. M. Lapointe and D. C. Rose (National Research Council, Ottawa). Can. J. Phys., 40: 687-97(June 1962).

The data from all four Canadian cosmic-ray stations were analyzed statistically with the help of an IBM 650 computer over the period from July 1957 to the end of 1960. The barometer coefficients for triple and double coincidences in the international cubical telescope and for the nucleon intensity in the standard neutron monitor were derived. A single correlation between intensity and pressure was used; two different ways of effecting this correlation were tried over a 6-month period. The results were compared and the best method was applied to the remaining three years. Monthly values were calculated, as were yearly values and values for the 3-year period. The results showed no significant seasonal variations in the barometer coefficients and no significant year-to-year variation. However, the seasonal fluctuations of the nucleon coefficient followed those of the meson. A small latitude effect seemed to be present. The nucleon coefficient at a high-altitude station, is larger than the one at a sea level station. (auth)

22835 SIZE SPECTRUM AND LATERAL DISTRIBUTION OF ELECTRONIC ENERGIES FOR EXTENSIVE AIR SHOWERS. James Roy Barcus (Univ. of New Mexico, Albuquerque). Dissertation Abstr., 22: 2835-6(Feb. 1962).

Two liquid scintillators of area 7.3 m^2 arranged as a single vertical telescope were used to study the cosmic showers The scintillation detectors together with their associated pulse analyzing circuits were located in temperature-controlled enclosures (70 ± 2°F) behind the Physics Building of the University of New Mexico at Albuquerque, 1575 meters above sea level. Provisions for introducing various kinds and thicknesses of absorber between these two detectors made it possible to determine experimentally the multiplication or attenuation of a sample of the shower particles which are found at different distances from the axis of the shower. The expected response of the scintillation system to showers of a given size whose axes fell a certain distance from the apparatus was determined by using the previous experimental work concerning the lateral distribution of the charged particles and the number spectrum of extensive air showers. Electromagnetic cascade theory was used to deduce the energy of the electronic component from the observed multiplicities by making assumptions regarding the ratio of the number and of the energy of photons to electrons. Each scintillator was in the form of a steel tank with a cylindrical bottom and a conical top. A DuMont Type K1328 Multiplier Phototube, which rested on the top ring, viewed the scintillation liquid. The scintillation solution was composed of 330 gal of toluene activated with 5.34 Kgms of p-terthenyl; 154 gms of PoPoP (1,4,-bis-2(5-phenyloxazalyl)-benzene) was added as a wave shifter. To study the large showers, which resulted in 10^2 or more particles traversing the scintillator, a circuit of large dynamic range was required to analyze the pulses from the photomultiplier. A circuit which logarithmically converted the amplitude of the photomultiplier pulse into a time duration of a standard amplitude pulse proved satisfactory. The time duration of the

pulses from the logarithmic converter was measured by a special timing circuit, and the result was stored in decimal counting units until the units were read by the recording apparatus. The master timing unit, which initiated the sequence of recording operations, also supplied an input gating pulse to the slave timing unit. Both solar and sidereal time were recorded for each event, as were also the barometric pressure and the temperature at ground level. A data conversion unit reduced all of the information to digital form, and the final recording was accomplished by means of an IBM card punch. The pulses from the logarithmic converter for the upper scintillator were coupled to the master timing unit and therefore used to trigger the recording apparatus. The pulses from the logarithmic converter for the lower unit were coupled to the slave timing unit. Each shower which produced a required minimum density of particles at the location of the upper scintillator resulted in the recording of the number of particles which traversed both the upper and lower detectors. This method of triggering the apparatus and of recording the data automatically provided a basis for the classification of shower size; in addition, the method also insured that a complete spatial distribution of shower axes were obtained. This latter circumstance made it possible to continue the study of the size spectrum which was previously carried out using only one scintillator. During the period from December 1959 to October 1960 over 10^5 events were analyzed according to the number of particles traversing the upper scintillator (p_{upper}) and about half that number according to multiplicity ($m = p_{lower}/p_{upper}$). In order to have a check on the method of determining the energies of the particles, and also to observe the transition effect, various thicknesses of absorber (Pb and/or H_2O) were used in 10 separate runs. Each run consisted of approximately 10^4 events and lasted about 3 weeks. In analyzing the individual runs 7 divisions were made according to the number of particles traversing the upper detector for the purpose of obtaining the integral size spectrum. The individual spectra could consistently be fitted by a straight line on a log-log plot; this indicates an integral size spectrum of the form $H(\geq p) = H_0\, p^{-\gamma}$. The best values of the logarithmic slope γ and of the constant H_0 were calculated according to the weighted average of the 10 sets of data. The data were analyzed from both the points of view of external and internal consistency to detect any possible systematic variation. No such variation was found, and the observed fluctuations could be entirely accounted for by the experimental errors. The experimental distribution obtained represents the response of the upper scintillator to extensive air showers whose integral number spectrum is $R(\geq N) = (2.12 \pm 0.20) \times 10^{-7}\ (N/10^6)^{-1.54 \pm 0.01}$ $m^{-2}\ sec^{-1}\ str^{-1}$. The values of the exponent and the rate constant describing the number spectrum of extensive air showers in the range $10^4 \leq N \leq 10^7$ obtained in this experiment are in good agreement with those established by means of other methods based on the measurement of the density spectrum. The runs using $\frac{1}{2}$ in. and 2 in. of Pb and 1 ft, 2 ft, 3 ft, and 4 ft of H_2O absorber were analyzed for multiplicity. No dependence on the mean size of the shower in the range $10^4 \leq N \leq 10^7$ was found. The results show that the total electronic energy per electron increases from the order of 10^8 ev near the periphery of the shower to somewhat greater than 10^9 ev in the vicinity of the axis. In the range $3 \lesssim r \lesssim 30$ meters the lateral distribution of electronic energy is well represented in the form r^{-n} with $n = 0.7$. Comparison of these results with those of similar investigations near sea level and at mountain elevations seems to show a gradual steepening of the lateral distribution of electronic energy with increasing height of observation. This is considered as evidence in favor of an often reported similar trend in the spatial density distribution. The transition curves for a water absorber show that use of a low-Z absorber has resulted in a clear separation of the effects of the incident electrons as distinct from those of the photons over a wide range of distances. The results obtained indicate that near the periphery of the shower a greater share of the total electronic energy is carried by the photons; whereas, at distances approaching the axis the electrons and photons contribute about equally to the total electronic energy. The curves also indicate that the ratio of photons to electrons is approximately unity. These features are characteristic of pure electromagnetic showers.

22836 EXTENSIVE AIR SHOWERS. Francis Richard Kendziorski (Cornell Univ., Ithaca, N. Y.). Dissertation Abstr., 22: 2842(Feb. 1962).

Extensive air showers were studied over a wide range of shower sizes ($N \approx 10^4$ to 10^{10}). For $N \geq 10^7$, the lateral distribution function agreed well on the average in the region $x > 3$ with $D = (0.0338/r_1^2)\ x^{-0.75}\ (x+1)^{-3.25}\ (x+12)\ m^{-2}$ where r_1 = one Moliere unit = 82 meters in Ithaca, N. Y., and $x = r/r_1$. A slight flattening of the lateral distribution was observed with decreasing shower size also with increasing zenith angle. For 685 showers in the size region $N \geq 10^7$ particles, the size and zenith angle distributions were measured. The results translated to sea level are represented by the following formula: $H(>N) = H_0\ (N/10^6)^{-\gamma}$ $\exp -(t - t_0)/\Lambda$ where $H_0 = (3.58 \pm 0.28) \times 10^{-8}\ m^{-2}\ sec^{-1}$ $sterad^{-1}$, $\gamma = 1.84 \pm 0.06$, t_0 = vertical thickness of the atmosphere = 1033 gm/cm^2, $t = t_0\ sec\theta$, and $\Lambda = 121 \pm 7$ gm/cm^2. Counting rates of five coincidence channels registering showers of median size 2×10^4, 6×10^4, 2.7×10^5, 1.4×10^6, and 7.5×10^6 particles were correlated with atmospheric pressure and ground temperature. The pressure coefficient appeared nearly constant at 10.8%/cm of Hg. The temperature coefficient (α) varied with season of the year as well as with shower size. The seasonal variation was expressed as a variation of α with temperature, and a tentative explanation was proposed in terms of atmospheric humidity. By analytically subtracting the experimental "humidity effect," values of α were obtained that increased monotonically with shower size from -0.27 to $+0.66$%/°C. These values of α agreed with those predicted on the basis of the computed expansion of lateral dimensions of the showers with increasing atmospheric temperature. The derived humidity coefficients decreased monotonically with shower size from $+0.37$ to -0.57% per mm Hg of water vapor. The absorption length (Λ) of the number spectrum, obtained from both pressure and zenith angle coefficients, was nearly constant (125 gm/cm^2) for $N < 10^7$ and slowly increased with shower size beyond about 3×10^7 particles. (Values of Λ derived from the variation of the counting rate with pressure were corrected by 10% for the mean secant of the zenith angle of the showers and were also corrected, by means of the temperature coefficients, for the change of counting rate with atmospheric density.) The particle absorption coefficient (k), computed from the expression $x = (\gamma\Lambda)^{-1}$, decreased in magnitude with increasing shower size. The absorption coefficient of the electrons was found to be substantially lower than that predicted by the cascade theory, $\lambda_1(s)$, for $N < 10^6$ but merged into $\lambda_1(s)$ for $N > 10^7$. An attempt to make a direct measurement of k from the azimuthal asymmetry of particle density in inclined showers gave the result $k = 0.0026 \pm 0.0009$ cm^2/gm for showers of mean size, 2.06×10^7 particles. From this value the computed absorption coefficient of the electrons in such showers is $k_{e1} = 0.0030 \pm 0.0012$ cm^2/gm. This value of k is somewhat below that predicted by cascade

theory, but is consistent with the values derived from the barometric and zenith angle variations. The experimental values of particle absorption coefficients were interpreted in terms of a model of shower development in the atmosphere. It was proposed that the very large showers (more than 10^7 particles) are dominated by photon-electron cascades initiated near the top of the atmosphere, while smaller showers (10^3 to 10^5) are sustained near the base of the atmosphere mainly by local cascades initiated by the more penetrating nuclear component; and very small showers (N less than 100) are dominated by the residue of $m\mu$ mesons which are absorbed very slowly. It appears that showers of 10^{18} particles are just reaching their maximum development at sea level.

22837 A STUDY OF HIGH ALTITUDE NEUTRON DISTRIBUTION. William Patrick Reidy (New York University). Dissertation Abstr., 22: 4056(May 1962).

An Aerobee-150A sounding rocket instrumented with 44 BF_3 proportional counters and associated electronics was launched from Wallops Island, Virginia, on August 23, 1960, a geomagnetically quiet day, and reached a maximum altitude of 116 miles. The counters were of two different boron isotopic enrichments, which permits the determination of the counting rate due to neutrons and an evaluation of the background counts due to highly ionizing events. This experiment, which measured neutron density, gave results which are in good agreement with the results of previous measurements by the New York University Cosmic Ray Group in the equilibrium region. The neutron density measured above 50 miles was constant within the accuracy of the measurement and less than $3.7 \pm 0.4 \times 10^{-7}$ neutrons/cm^3. The background flux of highly ionizing events above 50 miles is 0.019 ± 0.001 particles/cm^2 sec. These results were compared with the extrapolation of previous balloon-borne experiments and the calculated flux in this region.

22838 IDENTIFICATION OF COSMIC RADIO SOURCES. G. M. Tovmasyan and R. K. Shakhbazyan (Inst. of Radiophysics and Electronics, Academy of Sciences, Armenian SSR). Izvest. Akad. Nauk Armyan. S.S.R., Ser. Fiz.-Mat. Nauk, 14: No. 5, 121-40(1961). (In Russian)

The optical identification of cosmic radio sources is divided into two steps: the identification of galactic accumulation and separation. It was shown that the major radio source is galactic accumulation. Out of 45 identifications only 5 belonged to single galaxies, the rest belonged to galaxy groups. Most radio emission represents special classes of galaxies, predominantly elliptical, or peculiar galaxies. The radio emission depends on various dispersion phenomena and the scale at which the phenomena appear. (R.V.J.)

22839 ON THE SEMIANNUAL VARIATION OF GEOMAGNETIC ACTIVITY AND ITS RELATION TO THE SOLAR CORPUSCULAR RADIATION. W. Priester and D. Cattani (National Aeronautics and Space Administration, New York). J. Atmospheric Sci., 19: 121-6(Mar. 1962).

The semiannual variation of geomagnetic activity has been in the past tentatively explained by two different theories, the so-called equinoctial hypothesis and the axial hypothesis. The latter relates the effect to the inclination of the sun's axis with respect to the sun-earth line, i.e., to the annual variation of the heliographic latitude of the earth. From a reëxamination of the data for geomagnetic activity calculated by Bartels (1932, 1940) there is a strong modulation of the amplitude of the semiannual variation during the eleven year period of the solar cycle, which is apparently related to the heliographic latitudes of the sunspot-zones and provides indirect support for the axial hypothesis. The amplitude of the modulation is 13% during the increasing phase of solar activity, when the mean sunspot latitude is 20°; it reaches 27% during the late decreasing phase when the mean sunspot latitude is 10°. Three axial-symmetric models are derived, which give the statistical distribution of the solar particle flux for three different 3-yr periods during the solar cycle according to mean sunspot-latitudes of 20°, 15° and 10°. The distribution in heliographic latitude is given by two Gaussian functions centered at the heliographic latitudes of the active zones, as defined by the mean latitudes of the sunspots. These models explain the observed semiannual geomagnetic variations, except for a phase-lag of 20 to 30 days. We suggest that a semiannual density variation of charged solar particles which are trapped in the earth's magnetosphere can provide the required phase-lag mechanism. This implies a lifetime for these particles of the order of one month. The models can also provide a quantitative explanation of the observed delay of geomagnetic activity behind solar activity during the 11-yr cycle. Furthermore, they are in reasonable agreement with preliminary results on the statistical latitude distribution of comets with ionized tails. A space probe in a heliocentric orbit is proposed in order to obtain further evidence on the latitude distribution of solar particle streams. (auth)

22840 ON μ MESONS IN EXTENSIVE AIR SHOWERS AT SEA LEVEL. Tuneo Matano (Tokyo Univ.). J. Phys. Soc. Japan, 17: 745-54(May 1962). (In English)

The lateral distribution of μ mesons in extensive air showers (EAS), as well as their energy spectrum and the relation between the total number of μ mesons and that of charged particles, are studied utilizing accurate data on EAS. The total number of μ mesons in EAS fluctuates over an order of magnitude in a given shower size. The lateral distribution of μ mesons does not seem to fluctuate, in spite of the fluctuation of the starting point of EAS. The experimental results are compared with calculations based on a simple model of development of EAS. It is concluded that the attenuation length of the nuclear active particles, which corresponds to μ mesons with an average energy of about 10 Bev, is 200 to 250 g cm^{-2} in air. (auth)

22841 THE DISTRIBUTION OF ENERGY IN EXTENSIVE AIR SHOWERS AND THE SHOWER SIZE SPECTRUM. H. R. Allan, R. F. W. Beamish, W. M. Glencross, D. M. Thomson, and R. D. Wills (Imperial Coll., London). Proc. Phys. Soc. (London), 79: 1170-82(June 1, 1962).

Extensive air showers in the size range $N = 3 \times 10^5$ to 4×10^6 were studied using an array of four water tanks, in which the shower particles are detected by the Čerenkov light they produce when passing through the water. The differential size spectrum of the showers has a rapid change of slope near $N = 6 \times 10^5$, the exponent changing from 2.3 ± 0.1 to 3.0 ± 0.15 with increasing N. The cascade multiplication or attenuation of the number of particles as they pass through the depth of water in the tanks is reflected in the amount of Čerenkov light produced, and from this effect an extimate was made of the effective exponent s, of the shower particle integral energy spectrum E^{-s}; s ranged from 0.58 ± 0.06 at less than 3 m from the shower axis, to 1.7 ± 0.3 above 30 m. (auth)

22842 DECAY ASYMMETRY OF COSMIC RAY MUONS. S. N. Sen Gupta and M. S. Sinha (Bose Inst., Calcutta). Proc. Phys. Soc. (London), 79: 1183-96(June 1, 1962).

Investigations of the decay asymmetry of cosmic muons were carried out in two energy bands, using a multiplate cloud chamber. Advantages of the cloud chamber are: the

decay electrons are detected from zero delay up to about 50 ns, which is never possible in the delayed coincidence method; the change of direction of the decay electrons in the absorbing material due to scattering is avoided by dividing the whole absorber into thin plates separated by gaps in which the electrons are observed. Even if these electrons are subsequently scattered, their original direction of emission is clearly observed. After careful scanning of about 36,000 photographs taken using a fourfold coincidence and anticoincidence system, about 1500 unambiguous μ-e decay events were selected. Of these, 1021 events corresponded to a muon momentum interval fo 0.30 to 0.40 Bev/c and 482 events to an interval of 1.3 to 1.4 Bev/c at the experimental station, at 2.2 km. The up-down ratios of electrons emitted are 1.17 ± 0.05 and 1.18 ± 0.08, respectively, which yield partial longitudinal polarizations of 0.34 ± 0.09 and 0.36 ± 0.11 after correcting for the depolarization effect of the atmosphere and moderator. No evidence was found for the increase in the degree of polarization with increase of momentum of the muons. The absolute magnitude of the polarization is consistent with a K/π ratio of about 5% in the pion spectral region at 0.2 to 5.6 Bev. (auth)

22843 POLARIZATION OF LOW ENERGY COSMIC RAY MUONS AT SEA-LEVEL. B. Dolgoshein, B. Luchkov, and V. Ushakov (Moscow Inst. of Engineering Physics). Zhur. Eksptl'. i Teoret. Fiz., 42: 949-55(Apr. 1962). (In Russian)

The degree of polarization of 0.2- to 1.55-Bev positive muons is measured at sea level. Within this energy range the degree of polarization increases by a factor of 1.50 ± 0.19, corresponding to an increase of the slope of the pion energy spectrum in an energy region of the order of several Bev. A value $K^+/\pi^+ = 0.22 \pm 0.18$ for the ratio between K^+ and π^+ mesons produced in the atmosphere is obtained by estimating the possible contribution of $K_{\mu 2}$-decay to muon production. (auth)

22844 CALCULATION OF FLUCTUATIONS OF THE LATERAL DISTRIBUTION OF LARGE ATMOSPHERIC SHOWER PARTICLES. Ch. A. Tretyakova and V. Ya. Shestoperov. Zhur. Eksptl'. i Teoret. Fiz., 42: 1061-2 (Apr. 1962). (In Russian)

The "age" (S) distribution of showers is calculated for showers containing a given number of particles N at a given depth in the atmosphere. The calculations are performed for $N = 10^5$, 10^6, 10^7. (auth)

22845 CALCULATION OF THE POLARIZATION OF LOW-ENERGY COSMIC RAY MUONS. V. Berezinskii and B. Dolgoshein (Moscow Inst. of Engineering Physics). Zhur. Eksptl'. i Teoret. Fiz., 42: 1084-7(Apr. 1962). (In Russian)

The polarization of vertical and inclined muon beams at sea level is calculated as a function of energy in the range from 0 to 2 Bev, under the assumption that all muons are produced in pion decays. It is shown that the polarization increases with the muon energy, and also that the polarization of the inclined beam is greater than that of the vertical beam at energies ≤200 Mev. (auth)

Criticality Studies

22846 (BAW-1199) REACTIVITY MEASUREMENTS ON UNPERTURBED, SLIGHTLY ENRICHED URANIUM DIOXIDE LATTICES. Arland L. MacKinney and Russell M. Ball (Babcock and Wilcox Co. Critical Experiment Lab., Lynchburg, Va.). June 1960. Contract [AT(30-1)-2602]. 21p.

Uniform lattice critical experiments with 3 and 4% enriched uranium dioxide, clad with stainless steel, were performed in ordinary water. These experiments were done with fuel pins, 0.500 inches O.D. with an active fuel length of 66.5 inches. The fuel pins were fabricated by swaging the UO_2 powders to 87% theoretical density, in stainless steel tubing. The final wall thickness was 0.0282 inches. The pitch spacings which were used and the volume fractions of materials present in the core are listed. The minimum critical radius obtained for the fully reflected cores is shown as a function of the ratio of water to equivalent uranium metal. Measurements of the differential reactivity as a function of water height for each lattice yielded the common straight lines of (differential reactivity)$^{-1/2}$ as a function of water height. Numerical integration of the differential reactivity curve yields the excess reactivity as a function of core radius. (auth)

22847 (HW-69300(Rev.)) A SEMI-EMPIRICAL METHOD OF ESTIMATING MATERIAL BUCKLINGS FOR SLIGHTLY ENRICHED URANIUM TUBES IN LIGHT WATER. C. L. Brown (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 5, 1962. Contract AT(45-1)-1350. 17p.

A semi-empirical method for calculating material bucklings for slightly enriched uranium tubes in light water is presented. Lattice parameters were calculated by the IDIOT code. Buckling was calculated by the one group critical equation, using an adjusted regeneration factor (eta) to obtain a correlation to measured values. Measured bucklings on tube lattices at 0.95, 1.0, 1.25, 1.44, 1.47, and 1.6% U^{235} were used in the correlation. The calculated and measured maximum bucklings at these enrichments agreed to within ±350 10^{-6} cm^{-2}. A curve of adjusted eta versus U^{235} enrichment is given. The reliability of the method is limited to the range of tube sizes and U^{235} enrichments used in the correlation. Beyond this range, the method is less reliable, but useful for lattice survey studies. (auth)

22848 A SHORT CUT TO FUEL ELEMENT CRITICALITY ANALYSIS. John J. Rizzo (New York Operations Office, AEC). Am. Ind. Hyg. Assoc. J., 23: 171-3(Mar.-Apr. 1962).

A method is presented for estimating the number of uranium-bearing fuel elements required for criticality, with a uranium to zirconium weight ratio of from 1 to 10% and an enrichment of 93.5%. (auth)

Elementary Particles and Radiations

22849 (AD-266549) RADIATION AND SCATTERING BY COLD, FINITE BEAMS. Technical Report No. AF-89. M. Scotto and P. Parzen (Johns Hopkins Univ., Baltimore. Radiation Lab.). Oct. 1961. Contract AF33(616)-6753. 55p.

Two problems are treated which involve scattering by electron beams and plasmas. The first is concerned with the scattering of cylindrical and plane waves by a cylindrical plasma. Scattered amplitudes are computed for zero and infinite confining magnetic fields, and the effect of a finite field is estimated by comparing the results for the two extremes. The second problem involves scattering of plane waves by an electron sheet. Here, scattered amplitudes are computed for an infinitely thin sheet confined by a magnetic field of arbitrary magnitude. (auth)

22850 (AROD-2543:7) ACCURACY OF THE CORRELATION METHOD FOR APPRECIABLE RADIOACTIVE

PARENT DECAY. Technical Report No. 5. Wesley O. Doggett (North Carolina State Coll., Raleigh. School of Physical Sciences and Applied Mathematics). May 1962. Contract DA-ORD-31-124-61-G49. 54p.

The average value, variance, and fractional standard deviation were theoretically evaluated for the statistical correlation method proposed by Gold'anski and Podgoretski for investigating radioactive cascades in secular equilibrium. The method provides the same information as the conventional coincidence method with the important difference that there are no inherent accidental coincidences. The case of a prompt parent-daughter cascade with arbitrary uncorrelated background activity in which the change in the source decay rate during the experiment is not negligible was treated. A new correlation function is proposed for this case which has an average value proportional to the cascade source strength and is independent of uncorrelated background activity that decays with the same half life as the cascade. (auth)

22851 (JINR-E-946) ANGULAR CORRELATIONS OF LEPTONS IN THE K-MESON DECAYS. B. N. Valuev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1962. 10p.

The angular correlation of the leptons $e\nu$ and $\mu\nu$ were calculated in K_{e3} and $K_{\mu 3}$ decays. It is convenient to compare these correlations with the experimental data if the probability of detection of an electron (or a μ meson) depends on its energy. The available experimental data agree well with a vector coupling and exclude scalar and tensor ones. (auth)

22852 (NP-11761) THE INFLUENCE OF K* AND PION RESONANCES AND HYPERON PARITIES ON K-NUCLEON SCATTERING. Erasmo M. Ferreira, Colber G. de Oliveira, and Prem P. Srivastava (Rio de Janeiro. Centro Brasileiro de Pesquisas Físicas). 1962. 28p. (Notas de Física Vol. IX, No. 4, p.45-71).

K-nucleon scattering is assumed to be due to processes in which intermediate states consisting of the vector meson resonances play important roles. These processes are evaluated using straightforward perturbation methods. Comparing the results with the experimental data available for both I = 1 and I = 0 isotopic spin states, it is found that the only combination of parities of hyperons for which agreement with experiment is possible is that given by $P(\Lambda KN) = P(\Sigma KN) = -1$, the coupling constants being $g_\Lambda^2 \simeq 5$ and $g_\Sigma^2 \simeq 2.3$. The two-pion isovector resonance is found to give negligible contribution to the scattering, while the exchange of the three-pion isoscalar resonance plays an important role. The contributions of the fourth order diagrams involving the K* resonance to the scattering in both isotopic spin states are strong and attractive. (auth)

22853 (NP-11838) DISPERSION RELATIONS FOR HYPERON DECAY (thesis). Technical Report No. 37. Edward Richard McCliment (Illinois. Univ., Urbana). May 1962. Contract ONR 1834(05). 85p.

In order to discuss the hyperon decay amplitudes by means of dispersion theory, relativistically invariant vertex functions are defined. It is the contention that, like the eigenvalue restrictions which give bound state parameters, weak and strong interactions can coexist only for certain types of strong interactions, i.e., those which satisfy eigenvalue restrictions arising from unsubtracted dispersion relations for the decay amplitudes. When the integrands of the dispersion relations are evaluated, they generate a set of coupled integral equations for the amplitudes. The kernels of these integral equations depend only on the strong interactions, and on the mass shell the solutions are linear and homogeneous in the decay constants if the weak link is treated in lowest order. The restrictions on the strong interactions of hyperon decay amount to a determination of the coupling constants $g_{\Sigma\Sigma\pi}$ and $g_{\Sigma\Lambda\pi}$ in terms of the pion nucleon coupling constant G. Evidence is found in favor of the even relative Σ-Λ parity assignment. In regard to weak interactions it is demonstrated that the $|\Delta I| = \frac{1}{2}$ rule can be obtained as a consequence of charge independence for strong interactions and the Σ lifetime and asymmetry from those of the Λ are calculated. The numerical results from the solution of the integral equations are presented. The application of the method to lepton decay is discussed and the inherent difficulties in this case are pointed out. (N.W.R.)

22854 (TID-15828) CHARACTERISTIC MODIFIED X-RAY SCATTERING. Technical Report No. 5. K. Das Gupta (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). May 1962. Contracts AT(04-3)-221 and Nonr-220(30). 27p.

The spectroscopic analysis of the scattered x rays from lithium, lithium oxide, lithium fluoride, beryllium, and boron irradiated by copper target radiation established the existence of sharp characteristic modified lines on the longer wavelength side of the primary beam. This is a new type of incoherent x ray scattering. The K term values of lithium, beryllium, and boron and the L_1 term value of fluorine in lithium fluoride were calculated from the observed modified lines and these are 58.1, 113.6, 199.0, and 40.6 ev, respectively. Taking into account the limits of error in these experiments the term values obtained by this new method agreed well with the values obtained by Skinner by the method of soft x-ray spectroscopy. (auth)

22855 (TID-15833) Λ^0 MAGNETIC MOMENT IN THE GOLDHABER MODEL. L. Landovitz (Yeshiva Univ., New York and L. Marshall (New York Univ., New York). [1962]. Contract AT(30-1)-2625. 21p.

A value of -1.5 ± 0.6 was reported for the magnetic moment of the Λ^0 hyperon. Methods of accounting for such a large moment are discussed. Of two possible group-theoretic models, one predicts zero moment, and the other predicts $\frac{1}{2}\mu(n)$ assuming no mass differences between baryons. Although this value is in agreement with experiment, the effect of mass differences may be large. The model of the Λ^0 hyperon proposed by M. Goldhaber accounts for a large negative value. (M.C.G.)

22856 (TID-15834) A STUDY OF THE CHERENKOV YIELD AT HIGH ENERGIES (thesis). William Joseph Larkin (Catholic Univ. of America, Washington, D. C.). 1960. Contract AT(30-1)-2419. 56p.

A study was made of the Cherenkov light yield that is obtained in a known simple geometry. The prediction that the total light yield at ultra-high energies should become very insensitive to the energy of the particle was tested by using the multi-Bev mesons in cosmic rays at sea level. It was found that the yield of Cherenkov light exceeds theoretical predictions and is apparently a function of meson energy at ultra-high energies. The Cherenkov spectrum was examined from three different geometrical and electronical arrangements. These three were compared among themselves, to the Tamm-Frank predicted spectrum, and to the results of past experiments. (M.C.G.)

22857 A MODEL WITH MULTIPOLE-TYPE GHOSTS. K. L. Nagy (Roland Eötvös Univ., Budapest). Acta Phys. Acad. Sci. Hung., 14: 11-14(1962). (In English)

A theory based on a relativistic model is discussed. In the one-particle sector, the model gives rise to dipole and tripole ghost states, while in the sectors containing higher

numbers of particles, ghost states with higher poles occur. (auth)

22858 DISPERSION RELATIONS IN THEORIES WITH INDEFINITE METRIC. K. L. Nagy (Roland Eötvös Univ., Budapest). Acta Phys. Acad. Sci. Hung., 14: 15-20(1962). (In English)

Dispersion relations in certain theories with an indefinite metric interpreted on a probability basis are discussed. Conditions under which ghost contributions appear are given. (auth)

22859 THEORY OF RESONANCE SCATTERING ON ATOMIC SYSTEMS. M. V. Kazarnovski and A. V. Stepanov (Lebedev Inst. of Physics, Moscow). Acta Phys. Acad. Sci. Hung., 14: 45-66(1962). (In Russian)

The resonance scattering probability is expressed in terms of a four-correlation function similar to Van-Hove's formalism for the Born approximation in which the scattering probability is expressed in terms of a pair-correlation function. The interference scattering problem is solved in terms of a three-correlation function. The formula for total (in energy but not in angles) resonance scattering probability is obtained for photon scattering. Neutron and photon scattering is calculated for cases having simple atomic systems (Boltzmann ideal gas, crystal, and "diffusing atom"). (auth)

22860 THE WAVES ASSOCIATED WITH THE INTERNAL STRUCTURE OF PARTICLES. Pierre Hillion and Jean-Pierre Vigier (Institut Henri Poincaré, Paris). Ann. inst. Henri Poincaré, 17: 149-208(1962). (In French)

In a previous work known relativistic wave mechanics associated with internal structure of elementary particles were developed. The concept of structure was discussed by showing how, for its existence, it was sufficient to postulate a certain spherical symmetry in such a manner that the quantization leads to wave vectors which are transformed according to a three-dimensional rotation group representation. In the present work the results obtained are generalized within the framework of special relativity. (J.S.R.)

22861 EQUATIONS OF WAVES ASSOCIATED WITH THE STRUCTURE OF BOSONS. Pierre Hillion and Jean-Pierre Vigier (Institut Henri Poincaré, Paris). Ann. inst. Henri Poincaré, 17: 209-28(1962). (In French)

In a previous study it was shown how permanent wave systems, characterized by invariant equations under the conjugated complex tri-dimensional rotation group can be associated with the structure of elementary particles. In the wave system the wave vectors are elements of invariant vectorial space under the $D(l^+,l^-)$ or $D(l^-,l^+)$ representation of this group, where l^+ and l^- take either integral values or semi-integral values which are independent of each other. In the present study all vectors independent of the quadrivector A_μ space and of the space of the antisymmetric tensors F^+_{ij} and F^-_{ij} are classified. A study is made to determine how each of these vectors, independent of the preceeding classifications, behaves under the transformation characterized by the operators J^+_3, J^-_3, S_3, which are the constants of motion. A relationship between the preceding classifications and the Nishijima–Gell-Mann elementary particle classification was sought and the isotopic spin, strangeness, and baryon number operators were interpreted. (J.S.R.)

22862 EQUATIONS OF WAVES ASSOCIATED WITH THE STRUCTURE OF FERMIONS. Pierre Hillion and Jean-Pierre Vigier (Institut Henri Poincaré, Paris). Ann. inst. Henri Poincaré, 17: 229-54(1962). (In French)

In a continuation of study of the waves associated with the structure of elementary particles two particular cases of $D(l^+,l^-)$ and $D(l^-,l^+)$ representations for which the sum $l^+ + l^-$ is a semi-integral are considered. (J.S.R.)

22863 RECORD OF THE VAVILOV-CHERENKOV RADIATION CONE FROM SINGLE PARTICLES. M. M. Butslov, M. N. Medvedev, P. I. Filippov, I. V. Chuvilo, and V. M. Sheshunov. Atomnaya Energ., 12: 412(May 1962). (In Russian)

The Vavilov-Cherenkov radiation is generated by the passage of charged particles through a transparent medium with a velocity exceeding the speed of light in that medium. The height and radius of the cone of this radiation are dependent on the velocity of the particles and the index of refraction of the medium; this makes it possible to measure the velocity of the particles. Such a cone was determined for single cosmic particles by means of electron-optical transformers which amplify the signal to such an extent that it may be photographically recorded. The experiments yielded a circular picture for the radiation cone; according to the calculation, this annulus must consist of separate light points as not more than 15 photons fell on 1 mm^2. The photographs showed an uneven distribution of the particles on the annulus and also indicated the presence of a continuous arc. The angle subtending the arc was found to be correlated to the angle of the Vavilov-Cherenkov radiation cone for a given material. In view of the scarcity of experimental data, it cannot be established yet with certainty whether this correlation is true or coincidental; further work is in progress. (TTT)

22864 RADIATION DAMPING IN CLASSICAL ELECTRODYNAMICS. Ted Clay Bradbury (Cornell Univ., Ithaca, N. Y.). Dissertation Abstr., 22: 2836(Feb. 1962).

Dirac's equations for the motion of a classical charged particle that include the effects of radiation damping were rederived for the special case of motion in one dimension. The method employed is that of using an accelerated frame of reference relative to which the particle is at all times at rest. In this way, the equations of motion can be obtained without the use of advanced fields. The theory developed in this way contains a divergence in the form of an integral from 0 to ∞ of the electrostatic energy density rather than the usual reciprocal of the electron radius. The calculation is done using the standard energy-momentum tensor of classical electrodynamics. It is shown that advanced fields can be used to subtract out the divergences. In the case of one-dimensional motion, it is shown that the over-all energy balance is maintained if it is assumed that the particle radiates energy according to the conventional radiation formula. In the case of hyperbolic motion, an accelerated frame can be found in which all time dependence is removed and in which there are only electrostatic fields. In this way, the radiation which is observed in an inertial frame can be completely transformed away. Thus a charged particle in hyperbolic motion relative to an inertial frame radiates, but a charged particle at rest in a gravitational field, as on the surface of the earth does not.

22865 ON THE GROUND-STATE ENERGY OF LIQUID HELIUM II. Clayton Drews Williams (Washington Univ., St. Louis). Dissertation Abstr., 22: 2840(Feb. 1962).

With the appropriate Iwamoto-Yamada cluster development to evaluate the expectation value of the Hamiltonian operator, $H = -(\hbar^2/2M)\,\Sigma_i \Delta_i + \Sigma_{i<j} V(r_{ij})$, the ground-state energy of a large uniform system of N bosons in volume Ω was calculated using the Jastrow-type variational trial wave function, $\Psi = \Phi e^{\frac{1}{2}U} = (1/\Omega^{N/2}) \exp[(1/2)\,\Sigma_{i<j} u(r_{ij})]$, and a Lennard-Jones pair interaction potential, $V(r) = 4\epsilon[(\sigma/r)^{12} - (\sigma/r)^6]$. Utilizing a procedure described by

Clark and Feenberg, the function u(r) was determined so that terms generated by the kinetic energy operator in the evaluation of ⟨H⟩ cancel more or less completely against the short-ranged repulsive component in $\underline{V}(r)$, with the result $u(r) = -\mu s(\sigma/r)^4$, where $s = (M\epsilon\sigma^2/\hbar^2)^{1/2}$ and μ is a variational parameter. Taking into account all zero- and two-junction clusters in the evaluation of ⟨H⟩ was not sufficient to preserve the extremum property in ⟨H⟩ as a function of $\rho = N/\Omega$ (after minimizing ⟨H⟩ with respect to μ) for the liquid helium II system. Thus the value of ρ was fixed by requiring the two-particle probability distribution function $p(r) = \rho - v(r)$ in the cluster approximations to possess the essential property that the liquid structure factor, $\int\{\delta(r) - v(r)\}\, e^{i\vec{k}\cdot\vec{r}}\, d\vec{r}$, vanishes at $k = 0$, or $\int v(r)\, d\vec{r} = 1$. The densities (ρ_m) and corresponding energies ($\langle H\rangle_m$, minimized with respect to μ) thus selected compare with the experimental values (ρ_{exp} and $\langle H\rangle_{exp}$) as follows: $\rho_m/\rho_{exp} = 0.28$, $\langle H\rangle_m/\langle H\rangle_{exp} = 0.44$ taking into account all zero-junction clusters; and $\rho_m/\rho_{exp} = 0.37$, $\langle H\rangle_m/\langle H\rangle_{exp} = 0.61$ taking into account all zero- and two-junction clusters.

22866 THE FREE MODES OF VIBRATION OF FERMI-DIRAC GAS. Joseph Newton Fritz (Cornell Univ., Ithaca, N. Y.). Dissertation Abstr., 22: 2845(Feb. 1962).

The behavior of the collective modes of oscillation of a highly degenerate, but otherwise classical, gas of electrons was examined. The Boltzmann equation, with a relaxation time, is used to describe the gas. A particular feature of the treatment is that the equilibrium distribution to which the gas relaxes is a local equilibrium, that is, it depends on space and time through the local temperature and density. The equation was linearized and the motion broken up into plane waves. A dispersion relation was found which gives three principal types of waves which correspond in the low-frequency limit to thermal diffusion, Debye screening, and the skin effect. The amplitudes and phases of various physical quantities associated with these waves and the departure of the waves from low-frequency behavior are discussed. A brief discussion is given of the way driving forces can excite these waves, and a generalized "dielectric constant" is obtained. Emphasis is placed on the thermal diffusion wave. In particular, the form of the temperature wave to be expected at high frequency from a sinusoidal energy input is given.

22867 THE APPLICATION OF GREEN'S FUNCTIONS TO THE QUASI-PARTICLE INTERACTIONS IN A MANY FERMION SYSTEM. Donald Holm Kobe (Univ. of Minnesota, Minneapolis). Dissertation Abstr., 22: 4048-9(May 1962).

In many Fermion systems where the pairing of particles with equal and opposite momentum and spin plays an important role, such as superconductors and nuclei, the most elegant means of taking the pairing correlation into account is by means of a canonical transformation to quasi-particles. A Hamiltonian is then obtained in which the diagonal part contains a significant part of the pairing interaction, and the rest of the Hamiltonian consists of interactions between the quasi-particles. The interaction between the quasi-particles is taken into consideration by using modern field theoretic techniques applied to the many body problem. The excitation energies of the system can be obtained from the poles of the Green's functions, which are generalizations of time dependent field correlation functions, and state amplitudes from their residues. Because the quasi-particle Hamiltonian contains terms which are not quasi-particle conserving, a generalization of the usual many-time causal Green's function is necessary. The "n + m line" Green's function is defined as $G_{nm}(1 = \ldots n; n+1, \ldots, n+m) \equiv i\langle T\{\alpha_1 \ldots \alpha_n \alpha^+_{n+1} \ldots \alpha^+_{n+m}\}\rangle$ where $j = (k_j, \sigma_j, t_j)$ and the creation and annihilation operators for the quasi-particles α^+_j and α_j, respectively, are in the Heisenberg picture. The operator T time orders the product, with a positive (negative) sign for an even (odd) permutation of the order of the operators. The expectation value is taken with respect to the ground state of the interacting particles, but can be extended to finite temperatures by an average with respect to a grand canonical ensemble. The spectral representation of this Green's function is then obtained by taking its Fourier transform. It is apparent from the form of the representation that the function has poles at the excitation energies. However, information about excitation energies can also be obtained from the two-time Green's function, which is obtained from G_{nm} by setting all the times equal to two different times. The spectral representation of the many-time Green's function is reduced to the spectral representation of the two-time Green's function. The equations of motion for the Green's function G_{nm} can be obtained by applying the identity operator in an integro-differential form, making use of the equations of motion of the operators in the Heisenberg picture, and taking the Fourier transform. The resulting set of integral equations is an infinite set in which the n + m line Green's function is given in terms of larger line Green's functions. The hierarchy of equations can be terminated by neglecting the interaction Hamiltonian for a sufficiently large line Green's function. Then a finite set of equations is obtained. Feynman type graphs are introduced which facilitate and elucidate the discussion of the equations. The theory of Green's functions so far developed is then applied to obtain the four line Green's functions in the pairing interaction approximation. First, the straight chain approximation is used which includes only the scattering of quasi-particles. The secular equation for the energy spectrum of "excitons," bound pairs of quasi-particles, with total momentum zero is obtained. Then the part of the Hamiltonian that includes the creation and annihilation of four quasi-particles from the vacuum is included, and the exciton spectrum is obtained. The part of the Hamiltonian that corresponds to the annihilation of one quasi-particle and the creation of three, and vice versa, is zero in the pairing interaction approximation. It is shown that the sum of all "dangerous diagrams," i.e., two quasi-particles being eventually created or annihilated, is zero in both approximations.

22868 THE MANY-BOSON PROBLEM. Albion Jerome Kromminga (Univ. of Minnesota, Minneapolis). Dissertation Abstr., 22: 4049(May 1962).

The theory of many-Boson systems was considered. A canonical transformation of the creation and annihilation operators was introduced in order to eliminate the single-particle zero-momentum state and allow the application of field-theoretic perturbation techniques. These techniques were used to give a simpler derivation of a result due to Belyaev and to prove a theorem about the excitation spectrum of the system. General techniques for calculating the Green's functions are discussed. The excitation spectrum was calculated to second order for small wave number for the case of a repulsive square-well potential.

22869 PHOTON ASYMMETRY IN THE BREMSSTRAHLUNG OF TRANSVERSELY POLARIZED ELECTRONS. Edward Stanley Sobolak (Univ. of Pittsburgh). Dissertation Abstr., 22: 4052-3(May 1962).

There is a left-right asymmetry in the bremsstrahlung emitted by transversely polarized electrons analogous to the left-right asymmetry in Mott scattering. The magni-

tude of this effect was calculated from the second Born approximation, where it appears in the cross terms between the matrix elements of order Ze^3 and those of order Z^2e^5. Principal contributions come from the Feynman diagram in which the photon is emitted between the Coulomb interactions with the nucleus, while the largest terms from the diagrams with the photon emitted before or after both Coulomb interactions are of relative order v/c compared to the principal terms. The contributions of all diagrams to relative order $(v/c)^2$ are included in the final result. As is the case in Mott scattering, the asymmetry in bremsstrahlung depends only on intermediate states which lie on the energy shell. The reason was not investigated, but a qualitative argument is presented which indicates that it is not unexpected. In order to reduce geometric complexity, the calculation was performed for forward electron momentum. The matrix elements for this case are listed explicitly so that other polarization dependent effects may be conveniently calculated. A discussion of the divergences associated with the no cut off limit of the Coulomb field, as they apply to bremsstrahlung, is also included.

22870 A ČERENKOV STUDY OF BOUND MUON DECAY. Raven Eldred Bergeson (Univ. of Utah, Salt Lake City). Dissertation Abstr., 22: 4053(May 1962).

The bound muon decay rate, $\lambda_d(Z)$, was measured in Zn and Fe using a cosmic ray counter. The counter had 2 ft^2 scintillators and a 2 ft^2 water Cherenkov counter in the telescope to select muons stopping in the target; decay electrons were detected by a thin scintillator and were absorbed in a 4 ft^3 CCl_4 Cherenkov counter so that, in addition to the decay curves, a rough comparative spectrum between positive and negative muon decays was obtained. The decay electron energies and the decay times were determined by measuring pulse heights and the distance between pulses on pictures taken of oscilloscope traces. The composite time distribution of decay electrons was obtained in Al, Zn, and Fe. Al was used to eliminate the need to know the decay electron detection efficiencies assuming that the decay rate in Al is equal to the free decay rate. Values of $\lambda_d/\lambda_0 = 1.070 \pm 0.094$ for Fe and $\lambda_d/\lambda_0 = 0.973 \pm 0.086$ for Zn were obtained. In addition to the error quoted, there were systematic errors of the order of 3% or 4%. While the results did not permit verification of the theoretical predictions nor of the anomaly at Z = 26, a study of the empirical spectrum indicated that if the anomaly does exist, there is no narrow energy region in which anomalously large numbers of decay electrons are emitted.

22871 RADIATION EMISSION FROM CHARGED PARTICLES IN FLIGHT OVER A SYSTEM OF METAL SPHERES OR CYLINDERS. A. Ts. Amatuni and A. N. Oganesyan (Inst. of Physics, Academy of Sciences, Armenian SSR). Izvest. Akad. Nauk Armyan. S.S.R., Ser. Fiz.-Mat. Nauk, 14: No. 5, 99-107(1961). (In Russian)

The spectral composition of radiation emission from non-relativistic charged particles at constant velocity over a sphere or a charged filament (cylinder) was found. In both cases the maximum frequency is found at $\omega \sim v/l$, where l is the trajectory length. In the case of cylinders, the emission is isotropic along the polar angle. Formulas are derived for m emission from identical spheres (or cylinders) when the emission of one sphere (or cylinder) is known. The simple formulas describing interference effects in the emission of charged particles moving through or over periodic structures are developed without $v \ll c$ approximation and are general in character. (R.V.J.)

22872 ON MEASUREMENTS OF CHARGED PARTICLE VELOCITIES. E. M. Laziev and V. A. Tumanyan (Inst. of Physics, Academy of Sciences, Armenian SSR). Izvest. Akad. Nauk Armyan. S.S.R., Ser. Fiz.-Mat. Nauk, 14: No. 6, 111-16(1961). (In Russian)

An attempt was made to measure charged particle velocities by employing the relativistic character of the interaction between particles and the electromagnetic wave field. The relativistic variations of the distance between the particle and the wave peak are evaluated by the radiation induced by accelerated electrons. (R.V.J.)

22873 TRANSITIONAL RADIATION FROM A CONTINUOUS FLOW OF CHARGED PARTICLE CLUSTERS. A. Ts. Amatuni (Erevan State Univ., Armenian SSR). Izvest. Akad. Nauk Armyan. S.S.R., Ser. Fiz.-Mat. Nauk, 15: No. 1, 109-14(1962). (In Russian)

The interference from transition radiation emitted by charged particle clusters is investigated. A mathematical analysis is made of perpendicular, parallel, and transverse motions of particles with various dielectric and magnetic properties. (R.V.J.)

22874 POLARIZATION OF TRANSITIONAL INCLINED INCIDENCE RADIATION. N. A. Korkhmazyan (Erevan State Univ., Armenian SSR). Izvest. Akad. Nauk Armyan. S.S.R., Ser. Fiz.-Mat. Nauk, 15: No. 1, 115-21(1962). (In Russian)

The angular and frequency distributions of transitional radiation were analyzed, and generalized formulas were derived for two intra-perpendicular polarizations, where waves with electric vectors parallel to the radiation plane are considered longitudinally polarized while those with vectors perpendicular to the plane were considered transversely polarized. (R.V.J.)

22875 THEORY OF PARTICLE SCATTERING BY AN ENERGY CENTER. B. A. Veklenko (Moscow Inst. of Power Engineering). Izvest. Vysshikh Ucheb. Zavedenií, Fiz., No. 1, 10-18(1962). (In Russian)

Auxiliary functions $\eta_l(r)(l = 1,...)$ were interpolated for determining the scattered particle wave function. The $\eta_l(r)$ functions satisfy first order differential equations. At an infinite point the obtained values coincide with the phase shifts of corresponding partial waves. The suggested auxiliary functions interpolated to Schroedinger's equation are sufficiently generalized to be used for other purposes. (R.V.J.)

22876 CHERENKOV RADIATION EMITTED BY LONGITUDINALLY POLARIZED PARTICLES. Meng-ha Li (Moscow State Univ.). Izvest. Vysshikh Ucheb. Zavedenií, Fiz., No. 1, 136-7(1962). (In Russian)

Quantum electrodynamics is employed in an investigation of Cherenkov radiation by longitudinally polarized charged particles with a proper self-magnetic moment moving in a ferrodielectric. (R.V.J.)

22877 ON THE NUCLEON MAGNETIC MOMENT. A. N. Kushnirenko (Kiev State Univ.). Izvest. Vysshikh Ucheb. Zavedenií, Fiz., No. 2, 87-90(1962). (In Russian)

The addition to the nucleon magnetic moment produced by bare nucleon interactions with a symmetric pseudoscalar meson field was calculated (with the assumption of pseudovector bonding between field and nucleon). (tr-auth)

22878 HIGH-ANGLE LIMIT IN LOW-ANGLE SCATTERING AND ITS EFFECT ON THE DETERMINATION OF SURFACE AREA. Daniel Caulfield and Robert Ullman (Polytechnic Inst., Brooklyn). J. Appl. Phys., 33: 1737-40 (May 1962).

The slope of the correlation function $\gamma(r)$ as $r \to 0$ is proportional to the specific surface of the scattering sample in principle, and is equal to zero in practice. A simple

model is investigated that illustrates the problem. Calculations are carried out to show how surface areas may be obtained from scattering data. (auth)

22879 ČERENKOV RADIATION FROM AN ELECTRON TRAVELING IN A CIRCLE THROUGH A DIELECTRIC MEDIUM. Ahmed Erteza (Univ. of New Mexico, Albuquerque) and John J. Newman. J. Appl. Phys., 33: 1864-8(May 1962).

The theoretical problem of determining the Čerenkov radiation from an electron traveling in a circle through a medium is analyzed, and the fields and resultant radiation from such a geometry are determined. A solution is achieved by a transformation of the fields. This transformation results in a solution as a summation of eigenfrequencies, each of which is separated by the frequency of the periodic motion of the electron. (auth)

22880 CALCULATION OF AVERAGES FOR PRIMARY RECOIL DISTRIBUTIONS. G. Leibfried (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 33: 1933-43(June 1962).

The slowing of an energetic particle in a random assembly of scattering centers is discussed. Certain averages for physically interesting quantities can be calculated in a general form, including unequal masses of scattering and slowing down particles. The averages refer to quantities such as the total distance traveled (L) and the vector distance to the final positions (x_i) and powers thereof. Two assumptions simplify the evaluation of the general results: The mean free path λ is a simple power of the energy E: $\lambda(E) \sim E^{\mu}$; the distribution $g(E;\epsilon)$ of energies ϵ after one collision with initial energy E does not change its shape with E: $Eg(E;\epsilon) = k(\epsilon/E)$. A special distribution of this kind is the hard core distribution. Under the assumptions, all calculations are reduced to the evaluation of an integral like $\int k(\eta)\eta^{\mu}d\eta$. For equal masses and the hard core distribution, averages of any power of L can be calculated, obtaining the distribution function of L, this being proportional to $L^{1/\mu} \exp(-L/\lambda)$. Under the latter assumption using an arbitrary $\lambda(E)$, results are given for special distributions and equal masses (including the hard core distribution). The evaluation of the averages requires simple integrals over λ for linear averages and double integrals for quadratic averages with known integral kernels. For unequal masses, approximations are discussed. (auth)

22881 SCATTERING OF AN ELECTRON BEAM BY A NEUTRAL GAS. P. Parzen (Republic Aviation Corp., Farmingdale, N. Y.). J. Appl. Phys., 33: 2062-4(June 1962).

Expressions are derived for moments of the distribution function of an electron gas, created by electron-beam passage through a slab of neutral gas. A spherical harmonic method including the effects of energy loss is used. The case of no energy loss is also considered. No special assumptions as to the angular behavior of the scattering cross section are made. It is assumed, however, that the mean free path is independent of speed. (auth)

22882 THEORY OF HIGH-ENERGY POTENTIAL SCATTERING. P. J. Lynch and B. C. Carlson (Ames Lab., Ames, Iowa). J. Math. Phys., 3: 440-50(May–June 1962). (IS-367)

The exact amplitude for scattering of a Schrödinger or Dirac particle by a static potential is rewritten in a two-potential form by splitting the potential into two parts, one of which contributes only to exactly forward scattering. Replacement of the exact wave function by a modified plane wave gives a high-energy approximation that is shown to be equivalent to the Saxon-Schiff approximation in the Schrödinger case. Corrections to the approximation are obtained in principle from a simplified series expansion of the exact wave function having the modified plane wave as leading term. The results for the approximate amplitudes at small and large angles, in the Dirac and Schrödinger cases, are reviewed. (auth)

22883 A NOTE ON PERTURBATION THEORY IN NEARLY PERIODIC SYSTEMS. Agnar Pytte (Dartmouth Coll., Hanover, N. H.). J. Math. Phys., 3: 472-4(May–June 1962).

It is shown that for a particle in periodic or nearly periodic motion, an integrated form of the equations of motion is an advantageous starting point for an approximate calculation of the orbit. The motion of a charged particle in a static, inhomogeneous magnetic field is used to illustrate how this approach avoids the difficulty of spurious secular terms to all orders of approximation. (auth)

22884 EXCITATION SPECTRUM OF A FERMION SYSTEM. S. Yanagawa (Univ. of Pennsylvania, Philadelphia). J. Math. Phys., 3: 540-8(May–June 1962).

By the method of "modes," the excitation spectra of a fermion system with singular interactions are obtained in three cases: one additional particle above and one hole below the Fermi surface; one additional particle above the Fermi surface; and two particles above the Fermi surface. The argument holds not only for low-density systems (nuclear matter with a hard-core repulsion), but also for the case of the interacting electron gas in the high-density region. The results are compared with perturbation-expansion formulas by using diagrams in the second- and third-order of the expansion in interaction strength. It is shown that in the approximation used the occupation probability function at temperature T has the same form as the Fermi distribution function. (auth)

22885 THE FOURTH-ORDER CONTRIBUTION TO SELF-ENERGIES OF THE BARYONS AND THEIR MASS SPECTRUM. Riazuddin (Punjab Univ., Lahore, West Pakistan). J. Nat. Sci. and Math., 2: No. 1, 13-21(Apr. 1962). (In English)

Fourth-order contribution to baryon self energies due to strong interactions is calculated to determine if certain coupling schemes generate mass differences of fourth-order baryons. Conclusions about the signs of the coupling constants are drawn. Global symmetry is consistent with pseudoscalar K mesons but not with scalar K as far as the mass splitting in fourth-order perturbation theory is concerned. (auth)

22886 NUCLEAR INTERACTION OF 500 Mev/c NEGATIVE K-MESONS WITH NUCLEAR EMULSION. A. Husain, M. H. Siddique, M. Haque, and S. R. Husain (Rajshahi Univ., East Pakistan). J. Nat. Sci. and Math., 2: No. 1, 22-8(Apr. 1962). (In English)

Measurements were made using a stack of Ilford G5 emulsion of dimension 7 × 4 in. × 600 μ exposed to 500-Mev/c K^- beam from the Bevatron. The mean free path for nuclear interaction in flight was 35.96 ± 2.2 cm. In the 10 cases of charged hyperons emitted from 131 K^--stars, 6 were interpreted as Σ^+-hyperons and 4 as Σ^--hyperons. The absence of high energy hyperons emitted from K^--stars indicated qualitatively that the cross section for K^- capture involving two (or more) nucleons was nil or quite small. Five examples of hypernuclei were found in analyzing the stars; 3 showed mesonic decay, while 2 showed nonmesonic decay. (auth)

22887 DOUBLET PARITY AND ITS CONSERVATION IN WEAK AND ELECTROMAGNETIC INTERACTIONS. K. H. Tzou (Institut Henri-Poincaré, Paris). J. phys. radium, 23: 73-7(Feb. 1962). (In French)

In a recently proposed M-doublet model of leptons and weak interactions, quantization rules of an M-doublet field are established and doublet parity of leptons, photons, and some weakly interacting baryons is defined. The invariance of an M-doublet field under inversion transformations is studied; it is shown that particles and antiparticles have the same doublet parity. Finally, doublet parity conservation and the corresponding selection rule are discussed in electromagnetic and weak interactions. (auth)

22888 QUANTUM THEORY OF THE NON-RELATIVISTIC ROTATOR AND OF ELEMENTARY PARTICLES OF ZERO STRANGENESS. Pierre Hillion (Institut Henri Poincaré, Paris). J. phys. radium, 23: 81-92(Feb. 1962). (In French)

The non-relativistic rotator theory is invariant under the R_3 group. A representation of R_3 with unitary operators in the Hilbert spaces of scalar, spinorial, and vectorial fields is established, and it is shown that the non-relativistic rotator quantum theory is invariant under the linear group, the elements of which are the preceding operators, of the base changes in these Hilbert spaces. We define P parity operator, C charge conjugation, T_3^H isospin, $\mathcal{J}_3^H$ isobaric angular momentum, $\mathcal{F}_3^H$ fermion number, Q^H charge. Choosing the Hilbert space $\mathcal{H}(R_3)$ as isobaric spin space the Nishijima Gell-Mann's relation $Q^H = \mathcal{F}_3^H - \mathcal{J}_3^H$ is established for zero strangeness fields. It is shown that pion and nucleon properties and their strong interactions are described through spinorial and vectorial fields. In order to introduce into the theory the electron, the neutrino, and the weak interactions, a suggestion is made. Utiyama's formalism provides the field and the electromagnetic interactions. To conclude, the invariance of Eulerian transformations of referentials is defined. (auth)

22889 AN INVESTIGATION OF π^- CONTAMINATION IN μ^- BEAMS. A. Citron, C. Delorme, D. Fries, J. Heintze, E. G. Michaelis, H. Oeverås, and Yu. Shtcherbakov (CERN, Geneva). Nuclear Instr. & Methods, 15: 121-8(Mar. 1962). (In English)

Two methods used to investigate a small contamination of negative pions in intense muon beams available at a 600-Mev synchrocyclotron are described. A total cross section method yields a measure of the total contamination and, thanks to its speed, permits a rapid optimization of the beam. A star-counting method relies on the large pulses given out by negative pions when captured in a scintillator at the end of their range. It is relatively slow, but gives detailed information on the range spectrum of the contamination, which is of value in capture experiments. Results obtained with both methods are described and compared. They indicate total contaminations of the order of 1% in the beams investigated. In the stopping range of the muons, contaminations of a few parts in 10^4 are observed. (auth)

22890 THREE-BODY PROBLEM WITH SEPARABLE POTENTIALS. I. BOUND STATES. A. N. Mitra (Univ. of Delhi). Nuclear Phys., 32: 529-42(May 1962). (In English)

The nuclear 3-body problem in which two particles are identical is investigated, by assuming separable potentials to operate between pairs. The separable interactions between n-p pairs were central s-state and tensor (s and d-states); the corresponding n-n interaction is in the s-state only. The exact wave function of the bound 3-nucleon system is obtained in a form admitting a simple physical interpretation and is easily amenable to mathematical treatment for applications in nuclear physics at low energies. An approximate calculation of the ground state energy of the triton was carried out by treating the Schrödinger equation as a direct eigenvalue problem without resort to variational techniques, for the case of pure s-state interactions between all the pairs (with parameters adjusted to fit the low-energy singlet and triplet nucleon–nucleon data). The binding energy is close to the actual value. (auth)

22891 THE PHOTODISINTEGRATION OF THE DEUTERON. A. Donnachie (Univ. of Glasgow). Nuclear Phys., 32: 637-51(May 1962). (In English)

Differential cross-sections and polarizations are calculated for photon laboratory energies to 130 Mev. Calculations are carried out for 4 and 6% deuteron D-state probability, the final state being described by the Gammel-Thaler type Y.L.A.M. phase parameters obtained in the analysis of Breit, et al. Electric dipole and quadrupole triplet transitions and magnetic dipole and quadrupole singlet transitions are considered, and the coupling taken into account. Results are compared with experiment and with those of calculations using Signell-Marshak phase parameters. (auth)

22892 THE PION-NUCLEON COUPLING CONSTANT. A. N. Kamal (Univ. of Liverpool). Nuclear Phys., 33: 63-9(May 1962). (In English)

Analytic properties of the pion–nucleon vertex functions are summarized. A direct proof of the identity of coupling constants met in pion–nucleon and nucleon–nucleon scattering is given. The physical meaning of the coupling constant is clarified by demonstrating that it is the normalization constant to the longest range part of the bound state wave-function in configuration space. (auth)

22893 A REMARK ON PERIPHERAL INTERACTIONS. R. J. N. Phillips (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nuclear Phys., 33: 124-5(May 1962). (In English)

At moderate energies, the one-meson exchange processes appear to be dominated by the lowest partial waves. It is unreasonable to assume that they are important simply because of their long range. (auth)

22894 INTERSECTIONS BETWEEN THE DIFFERENT BOUNDARY CURVES FOR THE FOUR POINT FUNCTION WITHOUT LOCAL COMMUTATIVITY. Goeran Erkisson (Univ. of Lund, Sweden). Nuclear Phys., 33: 165-76(May 1962). (In English)

Explicit equations determining the intersections between the boundary curves are given. The intersections are obtained from roots of 8th-degree algebraic equations. (L.N.N.)

22895 A FUNDAMENTAL PARTICLE MODEL. [Part II]. E. van der Spuy (Atomic Energy Board, Pretoria, South Africa and Oak Ridge National Lab., Tenn.). Nuclear Phys., 34: 341-66(June 1962). (In English)

A fundamental-particle model (E. van der Spuy, Nuclear Physics, 29: 400(1962)) is discussed. The model for baryons and mesons starts from a fundamental non-linear equation of motion for the field operator in the Heisenberg representation, with a formally symmetric self-interaction. Equations of motion are generated for particles and particle interactions from the equation of motion of the field by using the τ-function formalism. The equation of motion of a single baryon is discussed; confining the analysis to the mass shells and the asymptotic domain, a solution is found. This equation of motion is then completely integrated in momentum space for pseudoscalar, vector, and pseudovector self-interaction terms. A method is discussed for

finding the low-energy peripheral interaction of two baryons, from the fundamental equation. The vector and pseudovector types have explicitly velocity dependent terms, even in the lowest approximation. Possible conflicts between the demands of the low energy interaction of two baryons, and the baryon self-energy problem are discussed. It appears possible that the origin of self-energy lies in a very short range self-interaction. Numerical computations of the baryon self-energy problem are exhibited for meson mass parameters. Possible cases of self-interaction are discussed. These give the nucleon and Λ-baryon masses, with the basic mass $m_0 = 0$. In one case it is shown from the numerical results that the ghost mass appearing in the baryon propagator does not satisfy the asymptotic wave equation which the real masses do satisfy. It is further suggested that the leptons and the photon are associated with the notion of saturated compounds in the strong coupling theory. A strong coupling theory would then have the more massive strongly-interacting particles and the saturated compounds as lighter, weakly-interacting particles. A tentative sketch is given of a fundamental theory based on n, p, and Λ in strong self-interaction, in which strongly interacting hyperons and mesons appear, as well as weakly-interacting leptons and photons. (auth)

22896 A POTENTIAL MODEL REPRESENTATION OF TWO-NUCLEON DATA BELOW 315 Mev. T. Hamada and I. D. Johnston (Univ. of Sydney). Nuclear Phys., 34: 382-403(June 1962). (In English)

An energy-independent nucleon-nucleon potential model representing data below 315 Mev is described. The data include the effective range expansion parameters and the deuteron properties as well as the scattering data at higher energies. It is significant that the n-p data were represented by the energy independent potential model in a satisfactory manner. A quadratic LS potential was essential in the T = 0 state. The T = 1 potential differs little from these proposed. The phase shifts predicted by the model are in fair agreement with the solutions YLAM (T = 1) and YLAN3M (T = 0). (auth)

22897 ON THE KINEMATICS OF MANY-TAILS. V. E. Asribekov (Inst. of Scientific Information of the USSR. Moscow). Nuclear Phys., 34: 461-75(June 1962). (In English)

Relations are found connecting the invariant variables of the amplitudes of the Feynman graphs with n free ends (n-tails) and making it possible to express all possible invariant variables through 3n-10 independent variables. These relations reduce to a linear system of kinematic conditions from the momentum energy conservation law and (for $n \geq 6$) to an additional system of geometric conditions connected with the 4-dimensionality of space. The choice of independent variables for the amplitude of an n-tail for an arbitrary n is determined. An analysis is given of such a choice of independent variables (with adjacent subscripts) for which the geometrical conditions (a set of equations of fifth power, in the general case) reduce to a set of quadratic equations with respect to any of the variables. A graphic method is indicated for determining the desired relations between the invariants. (auth)

22898 RENORMALIZATION OF THE OPTICAL POTENTIAL DUE TO PAIRING CORRELATIONS. James E. Young (Univ. of Copenhagen). Nuclear Phys., 34: 476-82 (June 1962). (In English)

Modifications of the optical potential from the presence of pairing correlations were estimated. Suppression of a pair of quasi-particles, i.e., a vacuum fluctuation, renormalizes the real part of the optical potential. This is a small effect given the ratio: (gap parameter)^2/½ × (energy of optical model state). Generalization of the concept of a pairing bound state leads to the notion of low-lying, finite lifetime structures in the spectrum of two quasi-particle excitations. These states split off from those describing the scattering of a quasi-particle pair. The Schrieffer criterion (the energy difference of two states in the single quasi-particle spectrum should be approximately equal to the excitation energy for a collective state) for the existence of a bound quasi-particle pair may be understood in a single way. An adiabatic approximation is the underlying basis of the physical result. Both the real and imaginary parts of the optical potential are renormalized. (auth)

22899 PROPERTIES OF RESONANCE SOLUTIONS OF PION-PION SCATTERING. V. V. Serebryakov and D. V. Shirkov (Inst. for Mathematics, Novosibirsk, USSR). Nuclear Phys., 34: 500-4(June 1962). (In English)

General properties of the solutions (A. V. Efremov, et al, Scientia Sinica, 10: 812(1961)) are surveyed and the resonance solutions (V. V. Serebryakov and D. V. Shirkov, JETP, 42: 1610(1962)) aer discussed. (L.N.N.)

22900 DISPERSION THEORIES FOR LOW ENERGY SCATTERING. D. V. Shirkov (Inst. for Mathematics, Novosibirsk, USSR). Nuclear Phys., 34: 510-16(June 1962). (In English)

A review of low energy scattering theory based on the method of dispersion relations and spectral representations is presented. Theoretical approximations are analyzed using π-π scattering as an example. (auth)

22901 INTERACTING FERMIONS IN TWO DIMENSIONS. Bibhuti Bhusan Deo (Ravenshaw Coll., Cuttack, India). Nuclear Phys., 35: 61-70(June 1962). (In English)

The problem of interacting electron and neutrino fields is solved exactly in one space and one time dimension. Matrix elements of Heisenberg field operators are calculated exactly. It is found that there is scattering and production of particles. The possibility of a ghost state difficulty is also noted. (auth)

22902 EXPERIMENTAL DATA ON NUCLEON–NUCLEON INTERACTIONS AT ENERGIES > 100 Gev. N. A. Dobrotin, V. V. Guseva, K. A. Kotelnikov, A. M. Lebedev, S. V. Ryabikov, S. A. Slavatinsky, and N. G. Zelevinskaya (Lebedev Inst. of Physics, Moscow). Nuclear Phys., 35: 152-64(June 1962). (In English)

Individual nucleon–nucleon interactions are studied experimentally at energies of several hundred Bev. A considerable part of the showers produced is found to be asymmetrical in the center-of-mass system. Two inelasticity coefficients are determined for each shower in the laboratory system and "mirror system" (i.e., the system in which the incident particles are considered to be at rest). Both inelasticity coefficients are shown to be more or less equal for the symmetrical showers and essentially different for the asymmetrical showers. The linear dependence of n_s on M (the mass of the excited meson cloud) is established. (auth)

22903 ON MESIC ČERENKOV RADIATION. P. Smrž (Inst. of Physics, Czechoslovak Academy of Sciences, Prague). Nuclear Phys., 35: 165-7(June 1962). (In English)

With the help of the Klein-Gordon equation, a modification is presented of a model of multiple meson-production in high-energy nucleon–nucleon collisions, proposed by Czyż, Ericson and Glashow (Nuclear Phys., 13: 516(1959)). (auth)

22904 UNIVERSAL VECTOR INTERACTION MODEL. I. Yu. Kobsarev and L. B. Okun (Theoretical and Experi-

mental Physics Inst., Moscow). Nuclear Phys., 35: 311-18(June 1962). (In English)

Based on the Sakata model, a scheme of the elementary particles is proposed in which all primary interactions are universal and determined by vector meson fields. Apart from weak, electromagnetic, and strong interactions, consideration is given to a hypothetic f-interaction eliminating Λ-hyperon-neutron and muon-electron degeneracy. The possibility of the muon neutrino having, just as the muon, an f-interaction is discussed. In that case the cross sections for muon neutrino-nucleus interaction may exceed by 5 or 6 orders those arising from weak interactions. (auth)

22905 THE EFFECT OF CORRELATIONS IN NUCLEON-ALPHA SCATTERING. B. Landy and E. J. Squires (Univ. of Cambridge, Eng.). Nuclear Phys., 35: 319-23(June 1962). (In English)

The elastic forward nucleon-alpha scattering amplitude is calculated to second order in the nucleon-nucleon scattering matrix. The results show that incoherent scattering is important and that its inclusion improves agreement with experiment. The uncertainties remaining are discussed. (auth)

22906 VELOCITY DEPENDENT INTERACTIONS AND HIGH ENERGY NUCLEON-NUCLEON SCATTERING DATA. E. Werner (Universität des Saarlandes, Saarbrucken, Ger.). Nuclear Phys., 35: 324-41(June 1962). (In English)

The high energy differential cross sections for elastic neutron-proton and proton-proton scattering are evaluated for a charge-independent interaction composed of velocity-dependent central potentials and a static tensor potential. The calculations are performed for 100, 160, and 300 Mev laboratory energy. Agreement with experimental data is obtained. (auth)

22907 INDIRECT EXPONENTIAL COUPLING IN THE CLASSICAL MANY-BODY PROBLEMS. Emmanuel Meeron (Convair, San Diego, Calif.). Phys. Rev. 126: 883-6(May 1, 1962).

The usual coupling procedure consists of multiplying the interparticle potential, $U_N(r^N)$, by a coupling parameter λ and expanding thermodynamic functions in powers of λ. The Kirkwood variation couples only one particle of the system, resulting in an integrodifferential equation for distribution functions, which also can be expanded in powers of the coupling parameter. These expansions converge and are valid only for weakly coupled systems. If the Ursell f bonds are coupled instead of the direct interaction potentials, thermodynamic functions can be expanded in powers of the exponential coupling parameters; for actual physical systems these expansions are practically finite low-order polynomials in the coupling parameters. Integrodifferential equations for distribution functions are derived, and distribution functions are given by ratios of two practically finite polynomials in the exponential coupling parameters. The coefficients in these polynomials are finite even for strongly singular (e.g., hard sphere) potentials. The method provides a well-defined expansion parameter for the Kirkwood-Salzburg hierarchy and appears related to the f-bond chain summation and nodal expansion methods. Applications include: theory of fused salts and electrolytes, theory of ferroelectricity, ion pairing in semiconductors, equation of state of the high-temperature electron gas, and problems of phase transitions. The possibility of applying exponential coupling to quantum-mechanical systems is noted. (auth)

22908 STABILITY OF THE PLANE WAVE HARTREE-FOCK GROUND STATE. Fumiaki Iwamoto and Katuro Sawada (Univ. of California, San Diego, La Jolla, Calif.). Phys. Rev., 126: 887-91(May 1, 1962).

The condition that the plane-wave state is the lowest Hartree-Fock state of a large fermion system with repulsive interactions is investigated and applied to the systems with δ-type interactions, finite-range interactions, and long-range Coulomb interactions. For finite-range interactions, the plane wave state is stable in both the high-density and low-density regions, but may become unstable in the intermediate-density region. The high-density stable region disappears for δ-type interactions, while the low-density stable region vanishes for long-range Coulomb interactions. Especially for an electron gas, the critical value r_s is smaller than 4.5. A speculation concerning the transition of the true ground state is discussed. (auth)

22909 POLARIZATION OF THE RECOIL PROTON FROM THE NEUTRAL PHOTOPRODUCTION AT 800 AND 910 Mev. C. Mencuccini, R. Querzoli, and G. Salvini (National Lab. of Frascati, Italy). Phys. Rev., 126: 1181-2(May 1, 1962).

The measurements on the polarization of the recoil protons from the process $\gamma + p \rightarrow \pi^0 + p$ were extended to higher γ-ray energies, at 90° in the center-of-mass system. At 910 Mev, a polarization $P = -0.45 \pm 0.07$; at 800 Mev, $P = -0.42 \pm 0.10$. The rather high values of P agree with the hypothesis that the neutral photoproduction at 500 to 1000 Mev can be described by the three resonant states, and strongly indicate that the second and third resonance have opposite parity. The probable quantum numbers are: $T = \frac{1}{2}$, $J = \frac{3}{2}$, D pion wave for the second resonance; $T = \frac{1}{2}$, $J = \frac{5}{2}$, F wave for the third resonance. (auth)

22910 ELECTRON-PROTON SCATTERING AT LOW MOMENTUM TRANSFERS. P. Lehmann, R. Taylor, and Richard Wilson (Université de Paris, Orsay, France). Phys. Rev., 126: 1183-8(May 1, 1962).

The electron-proton scattering cross section was measured at 248.9, 104.81; 209.6, 149.75; and 139.3 Mev, 104.19°. The following were obtained: $F_1 = 0.767 \pm 0.025$, $F_2 = 0.707 \pm 0.028$, and $F_1/F_2 = 1.085 \pm 0.025$ at $-q^2 = 2.98$ f^{-2}. $F = 0.902 \pm 0.011$ at $-q^2 = 1.05$ f^{-2}. The last result agrees with previous measurements. (auth)

22911 GENERAL FORMALISM OBEYING INTRINSIC EXCLUSION PRINCIPLE. Wojciech Królikowski (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 126: 1195-1202(May 1, 1962).

The formalism for fermions introduced previously (W. Królikowski, Nuclear Phys., 23: 53(1961)) is the most general one, if p, n, Λ, Σ^+, Σ^0, Σ^-, Ξ^0, and Ξ^- are the only elementary baryons, and ν, ν′, e^-, and μ^- the only elementary leptons (ν and ν′ are two kinds of neutrinos). The most general form of the mass operator for all possible baryons is derived. On this level, π and K mesons are treated phenomenologically. The formalism is extended to mesons, and the most general form of the mass operator for all possible mesons is obtained. The formalism allows for a singly-strange isoquartet R and doubly-strange isotriplet D. There is a possibility of two new excited mesons. Masses of new mesons are estimated. A symmetry between strong interactions of baryons and mesons of different kinds is considered. (auth)

22912 REGGE POLES IN π-π SCATTERING. Geoffrey F. Chew (Univ. of California, Berkeley), Steven C. Frautschi, and Stanley Mandelstam. Phys. Rev., 126: 1202-8(May 1, 1962). (UCRL-9925)

The connection between Regge poles, bound states and resonances, and asymptotic behavior in momentum transfer is reviewed within the framework of the analytically continued S matrix, and a convergent iteration procedure is given for calculating the position and residue of a Regge

pole in terms of a given (generalized) potential. By examining the long-range potential in the π-π system, it is inferred that Regge poles should appear in the I = 0 and I = 1 states, and that the latter pole may be responsible for the ρ meson while the former may well dominate high-energy behavior at low-momentum transfer in the crossed channels. The connection of this possibility with forward coherent (diffraction) scattering in general is explored, and experimental predictions are emphasized. The short-range forces due to exchange of 4, 6, ··· pions are likely to be repulsive and must be included in some form if a consistent solution is to be achieved. (auth)

22913 LAGRANGIAN FORMULATION OF THE ZACHARIASEN MODEL. W. Thirring (CERN, Geneva). Phys. Rev., 126: 1209-12(May 1, 1962).

A Lagrangian formulation of the Zachariasen model (Phys. Rev., 121: 1851(1961)) is discussed. It contains a field having a continuous mass distribution describing pairs of particles. The significance of this model within the framework of axiomatic field theory is pointed out. (auth)

22914 K* AND K MESON POLE CONTRIBUTIONS TO LEPTONIC Λ DECAY. Richard E. Norton (Univ. of California, Los Angeles). Phys. Rev., 126: 1216-19(May 1, 1962).

An attempt is made to calculate the leptonic Λ decay rate on the basis of the known K_{e3} and $K_{\mu 2}$ decay rates. Unsubtracted dispersion relations are written for the relevant matrix elements of the strangeness-changing vector weak current, and the absorptive parts are approximated by retaining only the contribution from the K*. In this way the vector current contribution to the Λ decay is related to the known K_{e3} rate, the known effective π-K-K* coupling constant, and the Λ-p-K* coupling constant, determined from extrapolation of the associated production data. The axial vector contribution to Λ decay is related to the $K_{\mu 2}$ decay rate by writing unsubtracted dispersion relations for the divergence of this current and approximating the absorptive parts by keeping only the contribution of the K meson. The numerical consequences can only be evaluated once the Λ-p-K* is determined, but a crude estimate suggested by "unitary symmetry" yields a leptonic Λ decay rate a few times smaller than is suggested experimentally. (auth)

22915 REGGE POLES AND RESONANCES IN STRONG INTERACTION. David Y. Wong (Univ. of California, San Diego, La Jolla, Calif.). Phys. Rev., 126: 1220-4 (May 1, 1962).

The scattering of two particles via the exchange of a resonance system is considered. The exchanged resonance is approximated by a pole in the Regge representation. The composite nature of the resonance is taken into account in the Regge-pole description so that divergence difficulties are not encountered even though the exchanged resonance may be in a J = 1 state. The exchange of a $\pi\pi$ (I = 1, J = 1) resonance in pion-pion scattering is considered. This exchange mechanism produces a strong attractive force in the I = 1 scattering system. Whether this exchange force can reproduce a resonance at the observed energy depends on a dimensionless parameter in the representation. This dimensionless parameter is restricted to be positive and of order unity on the basis of a crude uncertainty-principle argument. The value of the parameter required to reproduce a resonance does fall within this range. However, the width of the calculated resonance is broader than the observed width by a factor of 2 to 3. This discrepancy is not unexpected since all other forces in the problem were not considered. (auth)

22916 PROOF OF PARTIAL-WAVE DISPERSION RELATIONS IN PERTURBATION THEORY. Noboru Nakanishi (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 126: 1225-6(May 1, 1962).

The partial-wave dispersion relation for the nucleon-nucleon scattering is proved in every order of perturbation theory. A partial-wave dispersion relation for the pion-nucleon scattering is proved only for the graphs in which the two external pion lines are attached to the nucleon open polygon. (auth)

22917 THEORY OF A P-WAVE π-Λ RESONANCE. Saul Barshay (Brandeis Univ., Waltham, Mass.). Phys. Rev., 126: 1232-4(May 1, 1962).

It is shown that a $P_{\frac{1}{2}}$ π-Λ resonance can conceivably occur as a consequence of the $P_{\frac{1}{2}}$ pion-nucleon resonance and the fact that the Λ hyperon can dissociate virtually into a $\bar{K}$ meson and a nucleon. Specific pion-hyperon interactions are not considered. (auth)

22918 MULTIPLE-SCATTERING ANALYSIS OF THE THREE-BODY SCATTERING PROBLEM. L. H. Schick (Univ. of Colorado, Boulder). Revs. Modern Phys., 33: 608-22(Oct. 1961).

Scalar-particle scattering by one scalar, spherically symmetric potential having a finite radius is discussed; methods for obtaining the scattering amplitude are reviewed. Application to the square-well potential is made. Methods for obtaining the total scattering amplitude in terms of individual amplitudes are applied to S-wave scattering by each of two spherically symmetric potentials of finite radius. Solution using the total Green's function for scattering from one potential is presented. The separable potential approximation for S-wave scattering is tested using two completely overlapping identical square wells. Integrals used to evaluate off-energy-shell scattering amplitudes for a square-well potential are evaluated, and a method used to treat S-wave scattering by two potentials is generalized to include scattering of all partial waves. (L.N.N.)

22919 THEORY OF DIFFUSE SCATTERING OF X-RAYS, NEUTRONS, AND ELECTRONS BY IONIC CRYSTALS CONTAINING CHARGED DEFECTS OR IMPURITIES. M. A. Krivoglaz (Inst. of Physics of Metals, Ukrainian SSR, Kiev). Soviet Phys.-Solid State, 3: 2674-9(June 1962).

The scattering of x rays and neutrons by charged defects in single crystals is considered. Account is taken of the fact that around such a defect there is not only deformation but also polarization of the lattice. The Debye screening of the field of the defects is also taken into account. The screened Coulomb fields produce some features in the intensity distribution of the scattering that can be used to detect charged defects. Particularly important effects can appear in piezoelectric substances because in such substances the displacements of the atoms fall off in inverse proportion to the first power of the distance from the defect, and not the second power as in other crystals. A treatment is also given of the features of the small-angle diffuse scattering of electrons, in electron-diffraction studies, which are due to the electric fields around charged defects. (auth)

22920 PHYSICS OF HIGH-ENERGY PARTICLES. THE NUCLEAR STRUCTURE. Trudy Inst. Yadernoi Fiz., Akad. Nauk Kazakh. S.S.R., 5: 1-172(1962). (In Russian)

Sixteen papers are included on generation of mesons by singly- and multi-charged cosmic particles and on interactions of 0.66 and 9 Bev protons with atomic nuclei and free nucleons. Studies were also made of new devices for nuclear spectroscopy and of properties of excited nuclei.

Several papers are concerned with γ-ray reactions with substances and neon photospallation. Individual abstracts were prepared. (R.V.J.)

22921 INVESTIGATION OF CERTAIN INELASTIC p-n INTERACTIONS AT 9 Bev. V. A. Botvin, Zh. S. Takibaev, I. Ya. Chasnikov, E. G. Boos, and N. P. Pavlova. Trudy Inst. Yadernoi Fiz., Akad. Nauk Kazakh. S.S.R., 5: 3-15 (1962). (In Russian)

The combined π meson and proton angular center-of-mass distribution is symmetric. The separate proton and π-meson angular center-of-mass distribution is asymmetric with a negative sign (the π mesons escape to the front while the protons move to the back semisphere). Energy spectra of center-of-mass protons are harder than that predicted by the statistical theory considering isobars. Half the energy expended on meson production is carried away by π^0 mesons. The numbers of π^0 and π^+ mesons are identical when the energy spectra of neutral and charged mesons coincide. The mean energy carried away by one charged π meson and one proton does not depend on the type of reaction. (R.V.J.)

22922 ANALYSIS OF p-n INTERACTIONS GENERATED AT $E = 10^{10}$ ev IN NUCLEAR PHOTOEMULSION. E. G. Boos, Zh. S. Takibaev, V. A. Botvin, I. Ya. Chasnikov, and N. P. Pavlova. Trudy Inst. Yadernoi Fiz., Akad. Nauk Kazakh. S.S.R., 5: 16-32 (1962). (In Russian)

An analysis was made of proton-nucleon showers in order to determine the relationship between angular and energy characteristics and the multiplicity. The conditions $n_s + n_h < 1$, and absence of recoil nuclei were used as selection criteria. All events were classified by multiplicity. The number of (N) interactions within each group, the half angle ($\Theta_{\frac{1}{2}}$) and geometric average (Θ_g) angle are tabulated. The data show that the angular distribution of shower particles expands with an increase of multiplicity. The results are in good agreement with published data obtained by H. Winzeler at 6.5 Bev. (R.V.J.)

22923 MULTIPLICITY AND ANGULAR DISTRIBUTION IN SHOWERS FORMED BY 5×10^{11} TO 10^{14} ev NUCLEI. A. A. Loktionov. Trudy Inst. Yadernoi Fiz., Akad. Nauk Kazakh. S.S.R., 5: 33-64 (1962). (In Russian)

The multiplicity and angular distribution was studied as a function of primary particle energy in nuclear showers. The studies were carried out in emulsion chambers at 25 to 30 km altitude above the Moscow region in 1955 to 1958 and in Italy in 1955. The multiplicity and anisotropy dependence differ in nucleon and nuclear active showers. For α showers with 5×10^{10} to 10^{14} ev per nuclei the $n_s = 7.04\ (E/2M)^{0.18 \pm 0.02}$ ($l < 2$), $n_s = 11.53\ (E/2M)^{0.29 \pm 0.01}$ ($l \geq 2$), and $n_s = 8.75\ (E/2M)^{0.19 \pm 0.03}$ for all showers without H − H showers. For showers with H − H the $n_s = 10\ (E/2M)^{0.05}$. The angular distribution anisotropy in showers formed by nuclei ($\sigma = 0.412 \pm (0.066 \pm 0.008)$ lg (E/2M) increases slower energy in showers formed by nucleons ($\sigma = 0.268 + 0.146 \pm 0.009$) lg (E/2M). It was assumed that in nucleus-nucleus collisions, only central nucleon-nucleon interactions take place. The angular distribution with two maximums, for showers formed by nuclei, was found at $> 5 \times 10^{12}$ ev/nucleon. In interactions with emulsion nuclei the high-energy α particles ($\gtrsim 5 \times 10^{10}$ ev/nucleon) react only with the tube. The mean value N_h utilized for measuring the nuclear excitation of the target is determined by the tube volume and does not depend on initial α particle energy, $N_h = (0.85 \pm 0.1)\ A_\alpha (l + 1)$. 98 references are included. (R.V.J.)

22924 SPALLATION OF Al, Mo, AND W BY 660 Mev PROTONS. V. A. Botvin. Trudy Inst. Yadernoi Fiz., Akad. Nauk Kazakh. S.S.R., 5: 65-82 (1962). (In Russian)

Characteristics of Al, Mo, and W spallation by 660-Mev protons were studied using the Zh. S. Takibaev (Zhur. Eksp. i Teoret. Fiz. 24: 233, 1953) method of "embedded" filaments. Filaments of Al, W, and Mo were clamped between two photoplates and exposed to a synchrotron proton beam. The medium-heavy Mo was selected for comparison with nuclear emulsion (Ag + Br) because their (A and Z) parameters almost coincide. (R.V.J.)

22925 NUCLEAR REACTIONS OF SECONDARY AND NUCLEAR-ACTIVE PARTICLES IN PHOTOEMULSION. G. Tleubergenova and P. Morozova. Trudy Inst. Yadernoi Fiz., Akad. Nauk Kazakh. S.S.R., 5: 83-7 (1962). (In Russian)

Production of secondary nuclear-active particles in photoemulsion at a primary proton energy of 9 Bev was studied, and it was found that the numbers of secondary stars formed in the absorber by fast nuclear-active charged and neutral particles are almost identical. It is also shown that the attenuation of the primary flux is compensated by the secondary nuclear-active particles generated along the thickness of the emulsion. The data confirmed the transitional effect of cosmic rays. (R.V.J.)

22926 RELATION OF ANISOTROPIC ANGULAR DISTRIBUTION OF SHOWER PARTICLES TO THE OTHER CHARACTERISTICS OF COSMIC RAY SHOWERS. L. A. San'ko. Trudy Inst. Yadernoi Fiz., Akad. Nauk Kazakh. S.S.R., 5: 88-95 (9162). (In Russian)

The angular distribution of showers produced by nucleon-nucleon and nucleon-nuclei interactions were studied using the two-center model. The relations of anisotropy, particle energy, multiplicity, and numbers of gray and black tracks were analyzed. It is shown that the anisotropy increases with increased primary particle energy in nucleon-nucleon and nucleon-nuclei showers. The angular distribution anisotropy depends on the n_s multiplicity; at $E > 10^{12}$ ev it increases and at $E < 10^{12}$ ev it diminishes in nucleon-nucleon and increases in nucleon-nuclei showers. The fast particle angular distribution anisotropy depends on the magnitude of the target nucleus. (R.V.J.)

22927 MULTICHARGED PARTICLES FROM STARS FORMED BY COSMIC RAYS. N. N. Lazarev, T. P. Lazareva, and Zh. S. Takibaev. Trudy Inst. Yadernoi Fiz., Akad. Nauk Kazakh. S.S.R., 5: 96-101 (1962). (In Russian)

Multicharged particles of stars formed by cosmic rays at ~30 km elevation were studied in the Po River plain in 1955 and in the Moscow region in 1957 and 1958. The charge of fragments stopped in the emulsion was determined by measuring the track width in the final 150 μ. The angular distribution of unstable Li^8 particles is nearly isotropic. The energy spectrum is in good agreement with the energy spectrum in evaporation theory, indicating that the major fraction of unstable particles is emitted during the evaporation of excited nuclei. The angular distribution of charged particles with Z = 3 (energy over 60 Mev) is anisotropic with $N_{forward}$ to $N_{backward} = 45/2$ and cannot be described by the evaporation theory. Angular and energy distribution of fast particles with $Z \geq 4$ agree with the hypothesis of particle appearance in cascade processes. (R.V.J.)

22928 APPLICATION OF PHOTOELECTRON MULTIPLIER PEM-12 IN SCINTILLATION SPECTROMETRY AND GAMMA DEFECTOSCOPY. O. D. Kovrigin and G. D. Latyshev. Trudy Inst. Yadernoi Fiz., Akad. Nauk Kazakh. S.S.R., 5: 102-6 (1962). (In Russian)

The spectral sensitivity of a Bi-Ag-Cs photocathode and a CsI(Tl) crystal was analyzed in order to determine the resolving power of the PEM-12 photomultiplier. The stability does not exceed 1% and the amplitude desired is 8%

per 1 Mev, which makes it suitable for spectrometry and γ defectoscopy. (R.V.J.)

22929 RETENTION OF MAGNETIC FIELD TOPOGRAPHY IN β SPECTROMETER. O. D. Kovrigin, N. V. Kolesnikov, and G. D. Latyshev. Trudy Inst. Yadernoi Fiz., Akad. Nauk Kazakh. S.S.R., 5: 107-10(1962). (In Russian)

The design is given of a $\pi\sqrt{2}$ double focusing β spectrometer. The 220-mm central magnet core is encased in an excitation coil constructed of steel. The radius of the equilibrium orbit is 500 mm. (R.V.J.)

22930 ON THE APPLICATION OF SCINTILLATION GAMMA-DEFECTOSCOPE. A. A. Arkhangel'skii and G. D. Latyshev. Trudy Inst. Yadernoi Fiz., Akad. Nauk Kazakh. S.S.R., 5: 117-27(1962). (In Russian)

Characteristics of photomultipliers are analyzed, and applications of scintillation γ spectrometers are discussed. A defectoscope using an inexpensive Co^{60} source proved to be an efficient instrument for simultaneous control and automatic recording of defectograms. (R.V.J.)

22931 DOPPLER BROADENING IN γ LINES IN GASES. A. F. Akkerman, E. Ya. Vil'kovitskii, and D. K. Kaipov. Trudy Inst. Yadernoi Fiz., Akad. Nauk Kazakh. S.S.R., 5: 128-34(1962). (In Russian)

The distribution of Doppler shifts in the γ quanta produced by nuclear recoil in β decay (or K capture) and in γ transitions was analyzed in order to determine Doppler line broadening at the expense of recoil from preceding decays and in order to construct microspectra. However, various factors in preceding decays influence the shape of the microspectrum. An evaluation is made of the effects of recoil source density and of chemical compound temperature on the shape of the microspectrum. A microspectrum was constructed for $Co^{60} \rightarrow Ni^{60}$. (R.V.J.)

22932 PHOTOSPALLATION OF NEON NUCLEI. A. N. Gorbunov, D. K. Kaipov, and K. G. Kuvatov. Trudy Inst. Yadernoi Fiz., Akad. Nauk Kazakh. S.S.R., 5: 135-46(1962). (In Russian)

The photospallation of neon nuclei was studied on a Wilson chamber synchronized with a synchrotron in order to determine the mechanism of electromagnetic emission interactions with nuclei, the mechanism of nuclear reactions, nuclear structure, and nuclear forces. Various types of neon reactions with charged particle yields were recorded with special apparatus that produced a stereoscopic image. The curve for the effective cross section of (γ,p) reaction was constructed. The maximum cross section is (11.48 ± 0.81) mb at photon energies of 18 to 20 Mev. Cross sections are calculated for various Ne reactions. The integral absorption cross section σ = (0.588 ± 0.0085) bn/Mev; the logarithmic moment of absorption cross section σ_b = (17.19 ± 0.025)b. The mean square radius of neon nuclear charge distribution $R_n = 2.529 \times 10^{-13}$ cm, and the radius constant $r_0 = 1.183 \cdot 10^{-13}$ cm were found from the value σ_b. The magnitude σ_{-2}, related to nuclear polarization, was calculated to be 0.619 mb/Mev, in good agreement with the theoretical value obtained with the collective nuclear model. The angular distributions for (γ,p), (γ,pn), and (γ,pα) confirm the direct dipole absorption of γ quanta by an individual nucleon. The observed isotropy at $E_\gamma < 5$ Mev and sharply expressed forward direction at $E_\gamma > 5$ Mev in (γ,pn) reactions indicate the contribution of quasi-deuteron photon absorption at high energies. (R.V.J.)

22933 BEAM INTERACTIONS IN MAGNETIC TRAPS. Zh. S. Takibaev. Trudy Inst. Yadernoi Fiz., Akad. Nauk Kazakh. S.S.R., 5: 147-54(1962). (In Russian)

The problem of utilizing colliding deuteron and triton beams for producing nuclear reactions was analyzed, and the feasibility of trapping these beams by means of a certain magnetic field configuration was discussed. (R.V.J.)

22934 EFFECTS OF NUCLEON ISOBAR WITH T = 1/2 ISOSPIN ON THE RESULTS IN STATISTICAL THEORY OF MULTIPLE PARTICLE FORMATION. I. G. Gol'yak and V. I. Rus'kin. Trudy Inst. Yadernoi Fiz., Akad. Nauk Kazakh. S.S.R., 5: 155-63(1962). (In Russian)

The presence of maximums in the total cross sections for π-p scattering and meson photoproduction by protons at 700 Mev confirms meson-nucleon resonance interactions at $T = \frac{1}{2}$ and $S^3/_2$. The inclusion of a new nucleon isobar in statistical theory for π-p interactions at 1.0, 1.4, and 4.5 Bev only slightly affected the desired results. The effect of the isobar at 1 to 5 Bev is suppressed by another $(^3/_2, ^3/_2)$, while at higher energies the effects of $(^1/_2, ^3/_2)$ (due to the larger mass) dominate the effects of $(^3/_2, ^3/_2)$. Insufficient data prevented any conclusions for the isobar (0,0) in the case of π^--p interactions at 1.4 to 4.5 Bev. (R.V.J.)

22935 RESONANCE INTERACTIONS OF PI MESONS WITH STRANGE PARTICLES (EXPERIMENTAL DATA). I. V. Chuvilo. Uspekhi Fiz. Nauk, 76: 329-50(Feb. 1962). (In Russian)

Experimental results are given which show that πΣ, $\pi\Lambda^0$, and πK interactions in the region from 100 to 300 Mev possess a resonance character. The masses are given as: $\pi\Lambda^0$-system (Y_1^*-particle) = 1385 Mev, half-width 20 Mev; $\pi\Lambda^0$-system (Y_0^*-particle) = 1405 Mev, half-width 20 Mev; πK-system (K^*-particle) = 835 Mev, half-width 16 Mev. The half-widths mean that the lifetimes of these particles are of the order of $4 \cdot 10^{-23}$ sec, longer than the well-known π-nucleon $(^3/_2, ^3/_2)$ resonance, but still of the same magnitude as the duration of strong interaction processes. The isotopic spin of Y_1^* is 1, of Y_0^* is 0, and of K^* is $^1/_2$. It is further noted that the Y_1^* particle is in an $S_{1/2}$-state, although $P_{1/2}$ cannot be excluded. There is no definitive evidence concerning the spin and parity of the πΣ-interaction, whereas the spin of the K^*-particle is either 0 or 1. In particular, it is pointed out, that the spin and parity determination of the Y_1^*-particle is of great significance to the "global symmetry" hypothesis of Gell-Mann. (TTT)

22936 SCATTERING OF MEDIUM-FAST ELECTRONS ON PLASTICS WITH EMBEDDED HEAVY METAL ATOMS. K. Keck (Universität, Mainz). Z. Physik, 167: 468-76(1962). (In German)

Scattering was observed of 70-kev electrons by Collodium foils containing elements of high atomic number (lead). The contents of lead are determined and the kind of distribution of lead in the foil is described. The differential cross section as a function of the angle of scattering approximates the cross section calculated by Sherman with lower contents of lead of the foils. Remaining deviations can be explained by screening effects of the electron cloud. (auth)

22937 QUANTUM THEORY CONSIDERATION OF THE RADIATION REACTIONS OF A RELATIVISTIC ELECTRON IN AN AXIALLY SYMMETRIC MAGNETIC FIELD. Fritz Gutbrod (Universität, Frankfurt am Main). Z. Physik, 168: 177-94(1962). (In German)

The influence on the orbit of the radiation, which a relativistic electron emits in an axially symmetric magnetic field, was evaluated in first order perturbation theory. By summing all squared matrix elements before performing the necessary integrations, a simple way of calculating radiation effects in classical and first quantum mechanic approximation is given. (auth)

22938 COMPTON EFFECT ON A PROTON IN THE DIPOLE APPROXIMATION. V. K. Fedyanin. Zhur. Eksptl'. i Teoret. Fiz., 42: 1038-46(Apr. 1962). (In Russian)

A refinement is introduced in the dipole "phase shift" approximation. It is demonstrated that experimental data on the energy and angular dependences of the differential cross sections for energies up to 180 Mev, and also calculations of the threshold singularities and estimates of the electric and magnetic "polarizabilities" of the proton, are in agreement with the calculations in this approximation. (auth)

22939 SCATTERING OF HIGH ENERGY ELECTRONS ON ELECTRONS AND THE DIPOLE STRUCTURE OF THE ELECTRON. E. M. Epstein (Inst. of Physics, Azerbaidzhan S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1103-5(Apr. 1962). (In Russian)

The differential cross section for scattering of high energy electrons by electrons is calculated by taking into account the anomalous magnetic and electric dipole moments. (auth)

22940 PHOTOPRODUCTION OF π^0-MESONS AT HIGH ENERGIES. V. M. Arutyunyan (Inst. of Physics, Armenian S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1112-14(Apr. 1962). (In Russian)

The pole diagram connected with decay of the π^0 meson gives a large contribution to the differential cross section for photoproduction of π^0 mesons on protons in the small angle region. The cross section for photoproduction of mesons moving in the forward direction grows as the cube of the incident photon energy in the laboratory system. (auth)

22941 DATA ON π-πINTERACTIONS DERIVED FROM τ-MESON PRODUCTION REACTIONS IN πp-COLLISIONS. Ya. Ya. Shalamov and A. F. Grashin (Inst. of Teoret. and Experimental Physics, Academy of Sciences, U.S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1115-21(Apr. 1962). (In Russian)

Multiple production of 2.8-Bev/c π mesons in πp collisions is studied by means of a bubble chamber filled with a mixture of xenon and propane. Strong interaction between two final-state π mesons is observed in the $\pi^- + p \to \pi^- + \tau^+ + p$ reaction. No interaction of the resonance type is observed for three final-state π mesons with an isospin I = 1. For all investigated reactions the energy and angular distributions of the secondary particles can be satisfactorily explained by assuming that pole diagrams yield a significant contribution. The $\pi^-\pi^0$ scattering cross section $\sigma_{\pi\pi} \geq 80$ mb for $\omega^2 = 20$ to 30 μ^2 (μ = pion mass), and rapidly decreases with growth of the π meson energy. (auth)

22942 THE SPIN OF THE ρ-MESON. A. F. Grashin and Ya. Ya. Shalamov (Inst. of Theoretical and Experimental Physics, U.S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1140-1(Apr. 1962). (In Russian)

The angular distribution of π^- mesons is well described by a $\cos^2\phi^*$ function at a momentum $p_0 = 7.2$ Bev/c for the reaction: $\pi^- + p \to \pi^- + \pi^0 + p$. This distribution of π^- mesons is obtained for the case of degeneracy of π^0 mesons on quasi-free protons in a freon mixture of $C_2F_3Cl_3$, and indicates that reactions of this type can be investigated by collisions on nuclei. This is the first direct experimental measurement of the moment of the resonant state of two pions at $\omega \approx 5\mu$ (J = 1). This resonance can be interpreted as a degeneracy and a subsequent decay of the vectorial ρ-meson as follows: $\pi^- + p \to \rho^{0,-} + (n,p) \to \pi^- + \pi^{+,0} + (n,p)$. There is no change in the spin state of the nucleon. (TTT)

22943 COMPLEX ORBITAL MOMENTS AND THE RELATIONSHIPS BETWEEN THE CROSS-SECTIONS OF VARIOUS PROCESSES AT HIGH ENERGIES. V. N. Gribov and I. Ya. Pomeranchuk (Inst. of Theoretical and Experimental Physics, U.S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1141-4(Apr. 1962). (In Russian)

The asymptotic behavior of the scattering amplitudes of particles in the diffraction is determined by the moving pole j(t) of the partial wave in the annihilation channel. Thus, the elastic scattering amplitude of strongly interacting particles should have the form $f(t)\ s^{j(t)}$, where s and t are the usual Mandelstam variables. The total cross section is constant, if j(0) = 1. However, for complex values of j, unitary theory predicts simple relationships between the total cross sections of various particles interacting at high energies. Thus, if $\sigma_{NN} \approx 40$ mbarn and $\sigma_{\pi N} \approx 25$ mbarns, we find that $\sigma_{\pi\pi} \approx 16$ mbarns. These relationships are derived by writing the unitary condition for the amplitudes of the partial waves in the annihilation t-channel at $4\ \mu^2 < t < 16\ \mu^2$ (μ = mass of the π-meson). It is found that $\sigma^2_{\pi K} = \sigma_{\pi\pi}\sigma_{KK}$. These relationships also hold for differential, elastic scattering, cross sections. It is proposed that $\sigma^2_{\gamma N} = \sigma_{\gamma\gamma}\sigma_{NN}$. The value of $\sigma_{\gamma\gamma}$ can be determined experimentally. The spin structures of the amplitudes of various processes turn out to be closely related to each other. All polarization experiments can be expressed by a single parameter. A large number of relationships between the amplitudes of reacting particles can be derived. (TTT)

22944 INTERACTION BETWEEN 153-Mev NEGATIVE π-MESONS AND HELIUM. Yu. A. Budagov, P. F. Yermolov, E. A. Kushnirenko, and V. I. Moskalev (Joint Inst. of Nuclear Research, Dubna, U.S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1191-1208(May 1962). (In Russian)

The interaction between 153 Mev π^- mesons and He^4 nuclei is investigated with a high pressure diffusion cloud chamber operating in a magnetic field. The total π-He^4 interaction cross section, elastic scattering cross section, and cross sections for a number of inelastic processes are determined by measuring the total π^- track length. The angular distribution of elastic π-He^4 scattering is of a diffractional nature with a distinct minimum (80°) and a secondary maximum (100°). Optical model calculations assuming a square well complex potential $V = V_R + iV_I$ show that best agreement with the experimental data can be obtained for $V_R = -(18 \pm 7)$ Mev and $V_I = -(63 \pm 6)$ Mev, $r_0 = 1.5 \times 10^{-13}$ cm. These values are in good agreement with those computed by Frank, Gammel and Watson from the relation between the optical potential and forward scattering amplitude for free π-p scattering. The angular distribution of quasielastic π^- scattering on bound nucleons is compared with the calculations of Watson and Zemach. The probability of multiple π^- scattering in the nucleus and the charge exchange scattering cross section are estimated. (auth)

22945 MEASUREMENT OF THE SPIN CORRELATION COEFFICIENT FOR pp-SCATTERING AT 660 Mev. V. I. Nikanorov, G. Peter, A. F. Pisarev, and Kh. Pose (Joint Inst. of Nuclear Research, Dubna, U.S.S.R.). Zhur. Eksptl.' i Teoret. Fiz., 42: 1209-11(May 1962). (In Russian)

The spin correlation coefficient C_{kp} for elastic scattering of 660 Mev protons by protons at an angle of 90° in the cms is measured. The result is C_{kp} (90°) = 0.22 ± 0.18. (auth)

22946 RECONSTRUCTION OF THE SCATTERING MATRIX NEAR THE THRESHOLD. A. I. Baz, L. D. Puzikov, and Ya. A. Smorodinskii. Zhur. Eksptl'. i Teoret. Fiz., 42: 1249-51(May 1962). (In Russian)

The information on the scattering matrix which can be

obtained by measuring the energy dependences of the polarization quantities relating to elastic scattering near the reaction threshold is analyzed from the viewpoint of a complete experiment. It is shown that the above-mentioned measurements significantly modify and facilitate phase shift analysis at the threshold energy and in some cases even render phase shift analysis superfluous. (auth)

22947 ANALYTIC PROPERTIES OF PARTIAL WAVE AMPLITUDES AND THE ASYMPTOTIC BEHAVIOR OF THE SCATTERING AMPLITUDE. V. N. Gribov (Leningrad Inst. of Physics and Tech.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1260-7(May 1962). (In Russian)

It is shown that if the simplest inelastic channels in the unitarity condition are taken into account, the partial wave amplitudes as a function of the moment can possess poles and singularities whose position is independent of energy. Assuming this result to be valid in the general case, it should follow that the asymptotic behavior of the scattering amplitude at high energies either yields a slowly decreasing cross section or is of the same kind as that discussed by V. N. Gribov (Nucl. Phys., 22: 249(1961)). (auth)

22948 CONTRIBUTION OF THREE-PARTICLE STATES TO THE SPECTRAL FUNCTION EQUATION. V. N. Gribov and I. T. Dyatlov (Inst. of Physics and Technology, Academy of Sciences, U.S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1268-77(May 1962). (In Russian)

The problem of how the spectral function p (s,t) can be expressed in terms of the absorption parts involved in the block diagram is investigated for a certain class of perturbation theory graphs containing three-particle intermediate states. (auth)

22949 SCATTERING OF NEUTRINOS ON NUCLEONS IN THE ANOMALOUS MUON INTERACTION MODEL. V. B. Mandeltsveig. Zhur. Eksptl'. i Teoret. Fiz., 42: 1278-82(May 1962). (In Russian)

The cross sections for scattering of neutrinos on nucleons due to neutral vector χ meson exchange, that is, in accordance with the Kobzarev-Okun model of anomalous muon interaction, are calculated. The values obtained for the cross sections are of the order of $\sim 10^{-31}$ cm^2; this signifies that experiments for verifying the theory should be feasible. (auth)

22950 ROLE OF THE BIPION IN π-MESON PRODUCTION IN NUCLEON–NUCLEON COLLISIONS. L. L. Nemenov, L. D. Solovev, and D. I. Khomskii (Joint Inst. of Nuclear Research, Dubna, U.S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1283-4(May 1962). (In Russian)

The contribution of the bipion diagram to the differential cross section for the process $N + N \rightarrow \pi + N + N$ is calculated. It is found that up to energies of 1.5 Bev the contribution of the bipion diagram is less than 10% of the contribution of the single-meson diagram. With growth of the total energy the relative role of bipion exchange increases. (auth)

22951 GENERALIZATION OF SYMANZIK'S THEOREM ON MAJORIZATION OF FEYNMAN DIAGRAMS. A. A. Logunov, I. T. Todorov, and N. A. Chernikov (Joint Inst. of Nuclear Research, Dubna, U.S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1285-93(May 1962). (In Russian)

Any Feynman diagram can be characterized algebraically by a certain rectangular matrix, the incidence matrix. An explicit expression is found for the quadratic form of an arbitrary diagram in the x and p representations in terms of the incidence matrix. The expressions obtained are used to prove and extend the Symanzik theorem. With these theorems a few diagrams are found which majorize all strongly connected diagrams of scattering processes in which mesons and nucleons participate. (auth)

22952 COLLECTIVE EXCITATIONS OF PARTICLES WITH NON-ZERO ANGULAR MOMENTUM PAIRING. V. G. Vaks, V. M. Galitskii, and A. I. Larkin (Moscow Inst. of Engineering Physics). Zhur. Eksptl'. i Teoret. Fiz., 42: 1319-25(May 1962). (In Russian)

Collective excitations are considered for a system of Fermi particles for which attraction in a state with non-zero angular momentum is predominant. In such a system, beside sound excitations, other collective excitations without a gap in the energy spectrum will exist. The velocity of these excitations can be expressed in terms of the gap in the single-particle excitation spectrum. It is pointed out that the solution for the ground state function with $\Delta(n) \sim Y_{lm}(n)$ is unstable. (auth)

22953 IMPULSE EXCITATION OF A SYSTEM OF WEAKLY INTERACTING PARTICLES. U. Kh. Kopvillem (Inst. of Physics and Tech., Kazan Branch of the Academy of Sciences, U.S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1333-43(May 1962). (In Russian)

The equations of motion of macroscopic quantities characterizing the nonequilibrium state of a many-particle system with a discrete energy spectrum and subjected to the strong action of a pulsed generator are deduced by applying the Schroedinger equation for the system. Simple algorithms for the operator transformations related to impluse excitation are derived. The general properties of pulsed generators and of physical systems leading to the appearance of oscillating and stationary response signals of the excited particle system are established. As an illustration of application of the general relations, the nonequilibrium states of electron and nuclear spin systems produced by cross magneto-acoustic excitation are investigated. The prospects of developing pulse techniques for investigating electric and orbital magnetic moment systems are discussed. (auth)

22954 HIGHER PARTIAL WAVES IN LOW ENERGY $\pi\pi$-SCATTERING. A. V. Efremov and D. V. Shirkov (Joint Inst. of Nuclear Research, Dubna, U.S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1344-53(May 1962). (In Russian)

Higher partial waves are taken into account in the equations for π-π scattering at low energies derived by the differential method. Their effect is shown to be small. A procedure of taking into account an infinite number of partial waves in the low energy equations is considered and found to be meaningless. (auth)

22955 ČERENKOV AND TRANSITION RADIATION FROM ELECTROMAGNETIC WAVES. G. A. Askaryan (Lebedev Inst. of Physics, Academy of Sciences, U.S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1360-4(May 1962). (In Russian)

A new radiation effect is considered. This is Cherenkov and transition radiation from a front or cluster of electromagnetic waves (or three-dimensional wave train or modulated ray) moving in a medium. In the edge region of the cluster the wave field creates an averaged (with respect to the carrier frequency) gradient force which acts on the electrons of the medium and polarizes the latter. This polarization of the medium surrounding the wave cluster will move together with it, that is, it moves with the wave group velocity. If this velocity exceeds the phase velocity of the waves in the frequency range under consideration, which is below the carrier frequency of the cluster wave field, then superlight radiation will be emitted from it at the characteristic Cherenkov angle. Similar transition

radiation effects should appear during passage of the wave cluster through the boundary of the two media. The magnitudes of these effects are estimated. The effects considered here open to a new class of radiation phenomena—the Cherenkov and transition radiation emitted by wave field clusters, that is, by electromagnetic rays and quanta but not by moving particles. (auth)

22956 UNITARITY SYMMETRY AND UNIVERSAL WEAK INTERACTION. I. Yu. Kobzarev and L. B. Okun (Inst. of Theoretical and Experimental Physics, Academy of Sciences, U.S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1400-3(May 1962). (In Russian)

A hypothesis is examined in which the strange particle lepton decay constant G_A is approximately four times smaller than the universal constant $G = 10^{-5}m^{-2}$ and the matrix elements for these decays satisfy conditions imposed by the unitarity symmetry of strong interaction. This hypothesis is in agreement with the experimental data available at present and permits some predictions to be made. Moreover, the spectra and polarization of particles emitted in $K_{\mu 3}$-decay and in lepton decays of the Λ hyperon are predicted. A verification of these predictions should elucidate the validity of the hypothesis. (auth)

22957 THE EFFECT OF ππ-INTERACTION IN NUCLEON ELECTROMAGNETIC FORM FACTORS. A. F. Grashin and V. N. Melnikov (Inst. of Theoretical and Experimental Physics, Academy of Sciences, U.S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1404-9(May 1962). (In Russian)

Isovector form factors of the nucleon are calculated in the two-meson approximation by taking into account π-π interaction. Use is made of the $\pi + \pi \to N + \bar{N}$ amplitude obtained by Galanin and Grashin and of a new expression for the electromagnetic form factor of the π meson which is inconsistent with that previously known for Breit-Wigner resonance in the π-π amplitude. It is shown that Breit-Wigner resonance does not yield nucleon form factors which agree with the experiments and that the results previously obtained are erroneous. However a result consistent with the experiments can be obtained for the case of kinematic resonance of the π-π amplitude for an energy of about 750 Mev (ρ-meson effect). (auth)

22958 VIOLATION OF $\Delta Q = \Delta S$ RULE IN K MESON LEPTONIC DECAYS AND BEHAVIOR OF WEAK INTERACTIONS AT HIGH ENERGIES. B. L. Ioffe (Inst. of Theoretical and Experimental Physics, Academy of Sciences, U.S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1411-3(May 1962). (In Russian)

Recently reported experimental data indicated a violation of $\Delta Q = \Delta S$ for K^* lepton decay, where $K^* \to \pi^+ + e^- + \bar{\nu}$ appears in addition to $K^* \to \pi^- + e^+ + \nu$. Moreover, the probabilities of either scheme are about identical. Thus the $K^* \to \bar{K}^*$ transition follows the interaction chain $K^* \to \pi^- + e^+ + \nu \to \bar{K}^*$ or $K^* \to \pi^+ + e^- + \bar{\nu} \to \bar{K}^*$. A diagram of $K^* \to \bar{K}^*$ matrix elements was evaluated, and it was found that if K^* decays according to both schemes then the magnitude of the K_1^* and K_2^* mass difference indicates either a break in lepton interactions or the lepton integrals (the closed loop) along the diagram do not possess quadratic divergence. In the latter case the quantum divergence (of the order of $G^n\Lambda^{2n+2}$) should be absent in any diagram where the lepton loop can be arbitrarily complicated by lepton interactions. (R.V.J.)

22959 π-π INTERACTION IN π^--p COLLISIONS AT 7.2 Bev. M. S. Oinutdinov, S. M. Zombrovskii, S. Ya. Nikitin, Ya. M. Selektor, and A. F. Grashin (Inst. of Theoretical and Experimental Physics, Academy of Sciences, U.S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1413-15(May 1962). (In Russian)

One-hundred-ninety-six events of elastic scattering were selected from 675 two-prong stars from π^--p interactions at 7.2 Bev. Among the remaining 479 events 142 had protons as positively charged particles. An analysis was made of events with 0.4 cm proton tracks and energies not exceeding 1.5 Bev/sec. A diagram was constructed of the $\pi^- + p \to p + \pi^- + k\pi^*$ reaction using the square of the total π-meson energy, ω, in $m_\pi c^2$ units. The obtained distribution at ω^2 is according to the emitted π-meson effective mass system. It is postulated that the largest number of events, observed at $\omega^2 \sim 30$, is the result of $\pi^- + p \to p + \rho^- \to p + \pi^- + \pi^*$ (where ρ^- is the previously observed ρ meson with ~750 Bev mass). The angular distribution of π mesons for $\omega^2 > 60$ (i.e., outside the resonance) is close to isotropic. A perceptible difference in the distribution in the center-of-mass system of the secondary π^- meson at $\omega^2 < 60$ and $\omega^2 > 60$ confirms a a postulation on the nature of the maximum at $\omega^2 \sim 30$. The cross section for ρ^- meson production by interaction is ~1 mb. Assuming a pole type diagram for the main contributor to the $\pi^- + p \to p + \rho^- \to p + \pi^- + \pi^*$ reaction, the scattering cross section $\sigma_{\pi\pi}$ is 300 ± 100 mb for ω^2 = 20 to 30. (R.V.J.)

22960 CONCLUSIONS ON THE MOVING POLE HYPOTHESIS FOR HIGH-ENERGY PROCESSES. V. N. Gribov, B. L. Ioffe, I. Ya. Pomeranchuk, and A. P. Rudik (Inst. of Theoretical and Experimental Physics, Academy of Sciences, U.S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1419-21(May 1962). (In Russian)

A series of relations for total cross section asymptotic values were recently derived on the basis of an hypothesis that the behavior of elastic scattering amplitudes at high energies is determined by the pole at the extreme right in a complex l-plane. An attempt is made to derive these relations by applying R-matrix reaction theory to annihilation channels, and certain conclusions were drawn. (R.V.J.)

22961 PROBABILITIES OF DECAY SCHEMES, $\pi^+ \to \pi^* + e^+ + \nu$ AND $\pi^+ \to \gamma + e + \nu$. A. F. Dunaitsev, V. I. Petrukhin, Yu. D. Prokoshkin, and V. I. Rykalin (Joint Inst. of Nuclear Research, Dubna, U.S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1421-4(May 1962). (In Russian)

In a previous article the authors reported data on π meson β decay, confirming a predicted small λ magnitude for π ($< 7 \times 10^{-3}$). Additional data are given from β-decay investigations with improved apparatus. The obtained decay scheme, $\pi^+ \to \gamma + e^+ + \nu$, is analyzed considering the vector current conservation hypothesis. Experiments with 0.6×10^{10} π mesons indicate that $\lambda = (1.1^{+1.0}_{-0.6}) \times 10^{-3}$ and $G = (1.14 \pm 0.37)G_\beta$, confirming the hypothesis on vector current conservation. (R.V.J.)

22962 SINGULARITIES OF THE EXPLICIT PART OF THE SCATTERING AMPLITUDE AT HIGH ENERGIES. P. Shurun'i. Zhur. Eksptl'. i Teoret. Fiz., 42: 1425-6 (May 1962). (In Russian)

Singularities of the explicit amplitudes at high energies are analyzed using the Mandelstam representation previously used to describe two types of singularities for the vertical amplitudes. (R.V.J.)

22963 DIFFRACTION OF THE ELECTROMAGNETIC WAVES ON PLANE METAL GRATES. Z. S. Agranovich, V. A. Marchenko, and V. P. Shestopalov (Inst. of Low Temperature Physics and Tech., Academy of Sciences, Ukrainian SSR and Khar'kov State Univ.). Zhur. Tekh. Fiz., 32: 381-94(Apr. 1962). (In Russian)

Formulas are developed for plane electromagnetic wave

diffraction on a plane periodic lattice formed by infinitely thin metallic bands with an arbitrary ratio between band width and slit width. The precise solution is expressed by an infinite series. The first coefficients of the series were calculated and approximation formulas were developed for constructing the coefficient curves. (R.V.J.)

Neutron Physics

22964 (CEA-2142) ETUDE DE LA DIFFUSION DES NEUTRONS RAPIDES. SECTION EFFICACE DE DEPLACEMENT. (Study of Fast Neutron Scattering. The Displacement Cross Section). Jean Paul Millot (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Fontenay-aux-Roses). 1962. 99p.

Thesis submitted to Univ. of Paris.

A method is proposed for calculating the biological efficiency of fast neutrons emitted by in-pile fission sources. This method justifies the empirical theory of Albert and Welton. In making simple assumptions concerning the cross sections, it is supposed that the propagation can be reduced to a mono-kinetic problem. A system of orthonormal functions is then set up making it possible to calculate the flux leaving a planar source. This method generalizes the results obtained by Platzek to the case where the elastic cross sections are not isotropic, and make it possible in particular to define a displacement cross section. This method can be generalized to the case of neutron diffraction as a function of time, and to the study of slowing-down. Numerical results are given for the following: H_2O, D_2O, Fe, Be, Pb, CH, CH_2, BeO, C, $Fe \cdot 3H_2O$, $Fe \cdot H_2O$, and $3Fe \cdot H_2O$. These cross sections were verified experimentally in water and in graphite for neutrons of 2, 5, and 14 Mev. (auth)

22965 (GAMD-680) THE CALCULATION OF MONATOMIC GAS SCATTERING KERNELS. J. Gauer (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Feb. 17, 1959. 7p.

A computer program, Sigma–Gas, for calculation of cross sections for neutron scattering by a monatomic gas was developed for use on the IBM 704. The maximum number of energies the code will handle is 75. Method of solution, input preparation, output, and operating instructions are discussed. (M.C.G.)

22966 (GAMD-2408) SIGMA–GAS, 7090 VERSION. J. Bell (General Atomic Div. General Dynamics Corp., San Diego, Calif.). July 17, 1961. Contract AT(04-3)-314. 3p.

A computer program, Sigma–Gas, for calculation of $\sigma(E_0 \rightarrow E)/\sigma_s$, the monatomic gas scattering kernel, was modified for use on IBM 7090. The upper limit of 75 energies was increased to 150. Input preparation and output are discussed. (M.C.G.)

22967 (LAMS-2692) AN ENERGY MEASUREMENT OF PuF_4 NEUTRONS AND THE NEUTRON DOSE RATE FROM PuF_4 PROCESSING EQUIPMENT. Dale E. Hankins (Los Alamos Scientific Lab., N. Mex.). May 1962. Contract W-7405-Eng-36. 13p.

By use of the multisphere neutron spectrometer, the neutrons emitted from a sample of PuF_4 were analyzed for average neutron energy. The results indicated an average neutron energy of 1.25 ± 0.25 Mev. The room background had a fast neutron energy of 1.00 ± 0.25 Mev, with a reasonably large contribution from scattered neutrons. A 110 gram sample of PuF_4 gave a dose rate reading of about 9 mrem/hr at a distance of 30 cm, which corresponds to a neutron yield of 8.0×10^5 n/sec. The room background was about 0.5 mrem/hr. Neutrons originating in the PuF_4 processing equipment were measured with the 10 inch sphere neutron survey instrument. Comparable readings were obtained with the converted PeeWee neutron survey instrument by using a correction factor of 30, or a fast neutron energy of 0.5 or 0.4 Mev. Either of these factors enabled a monitor to obtain a more accurate dose rate with the PeeWee than was previously possible. (auth)

22968 (SPM-423) CALCUL DE LA PROBABILITE P_{S1} POUR QU'UN NEUTRON SORTIE D'UN CYLINDRE CREUX SANS Y AVOIR SUBI DE CHOC. (Calculation of the Probability P_{S1} for a Neutron Passing Through a Hollow Cylinder Without Undergoing a Collision). A. Guillou and F. Roche (France. Commissariat à l'Énergie Atomique. Centre d'Etudes Nucléaires, Saclay). Mar. 7, 1958. 50p.

A program for calculating the probability P_{S1} for a neutron passing through a hollow cylinder without undergoing a collision was established using three closed subprograms. The three subprograms were an integration relative to the first integral, an integration relative to the second integral, and the function k. The setting up of these subprograms necessitated a preliminary mathematical study. (J.S.R.)

22969 (TID-15614) THE EXPERIMENTAL DETERMINATION AND ANALYTICAL VERIFICATION OF THE AGE OF Pu–Be SOURCE NEUTRONS IN GRAPHITE (thesis). Charles Urban Steichen (Kansas State Univ., Manhattan. Engineering Experiment Station). 1960. 98p.

Kansas State Univ. Eng. Expt. St., Spec. Rept. No. 6.

A series of experiments was undertaken to determine the age of Pu–Be source neutrons in graphite. Theoretical calculations were performed to predict the age from the calculated and measured source energy spectra. In these experiments, the age was determined by measuring the spatial distribution of the slowing down density at the 1.44 ev resonance of indium. The theoretical value of the age was obtained by calculating the age of the neutrons from source spectrum energies to fission spectrum energies and then adding to this the accepted value of the age from the fission spectrum to 1.44 ev. Data are presented in graphs and tables. The age for the Pu–Be source as determined experimentally was about 10% higher than the values previously reported. It agreed very well with the age as calculated. (M.C.G.)

22970 (AEC-tr-5168) THE MACROSCOPIC DIFFUSION OF NEUTRONS BY AN APPROXIMATE METHOD. J. Yvon. Translated by Eugene Gruber, Jr. (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh) from J. Nuclear Energy, 4: 305-18(1957). 20p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 11, abstract no. 6008.

22971 (JPRS-13609) SHIELDING PROPERTIES OF WATER, POLYETHYLENE, AND PLEXIGLASS. D. L. Broder, A. A. Kutuzov, and V. V. Levin. Translated from Inzhener.-Fiz. Zhur., Akad. Nauk Belorus. S.S.S.R., 5: No. 2, 47-51(Feb. 1962). 8p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 16, abstract no. 17059.

22972 ON THE CALCULATION OF FAST NEUTRON SPECTRA IN HYDROGEN-CONTAINING MEDIA. N. Papmehl and D. Schwalm. Atomkernenergie, 7: 161-9 (May 1962). (In German)

Studies were made of the energy spectrum of fast neutrons in a homogeneous, hydrogen-containing medium. Two numerical methods as well as an analytical approximation method are discussed for the solution of the integral equation for this energy spectrum. When applied to a H_2O

medium, the anisotropy in the center of mass system is taken into consideration almost exactly in the scattering on oxygen while the inelastic scattering and the finiteness of the medium is considered approximately. (auth)

22973 A STERN-GERLACH EXPERIMENT WITH NEUTRONS. H. G. Hasler and G. Weber (Inst. for Pure and Applied Nuclear Physics, Kiel). Atomkernenergie, 7: 170-2(May 1962). (In German)

A Stern-Gerlach experiment with slow monochromatic neutrons is described. A mechanical velocity selector served as a monochromator. The intensity distribution was measured 3-m behind the Stern-Gerlach magnet in a plane vertical to the neutron beam. The observed splitting of the beam into two partial beams was a confirmation for the spin $\frac{1}{2}$ of the neutron. The two Stern-Gerlach maxima were well resolved and had a distance of about 5 mm at a neutron velocity of 2400 m/sec. Their distance as a function of neutron velocity gave, within experimental error, the expected relationship of $1/v^2$. (auth)

22974 MATHEMATICAL EXERCISES IN NUCLEAR ENGINEERING. G. Mardus (Technische Hochschule, Berlin). Kerntechnik, 4: 198-201(May 1962). (In German)

A temporally constant point neutron source is considered, which emits fast monoenergetic neutrons into an infinite scattering medium containing only heavy nuclei. The spatial distribution of the thermal neutron flux is found, assuming that no capture takes place during the neutron slowing-down process. (T.F.H.)

22975 THE SPACE-TIME NEUTRON KINETIC EQUATIONS OBTAINED BY THE SEMIDIRECT VARIATIONAL METHOD. D. E. Dougherty (Knolls Atomic Power Lab., Schenectady, N. Y.) and C. N. Shen. Nuclear Sci. and Eng., 13: 141-8(June 1962).

Using a semidirect variational method, the time-dependent coefficients of a modal expansion of the neutron fluxes are given by the Euler–Lagrange equations obtained from a variational principle for the multigroup kinetic equations. In order to avoid the difficult task of determining orthogonal eigenfunctions for a modal expansion in a complex geometry, an approximate solution of the kinetic equations by the method of the Green's function results in a set of readily calculated space modes. These modes can also be adapted to perturbations in the diffusion parameters about which a priori information is available. (auth)

22976 VELOCITY DEPENDENT MILNE'S PROBLEM. R. Kladnik and I. Kuščer (Univ. of Ljubljana, Yugoslavia and "J. Stefan," Ljubljana, Yugoslavia). Nuclear Sci. and Eng., 13: 149-52(June 1962).

Infinite-medium solutions of the transport equation are used to obtain two integrals of this transport equation, to express the asymptotic approximation to the solution of Milne's problem, and to construct a variational trial solution. This solution is improved by one iteration. The linear extrapolation distance is expressed by the stationary value of the variational functional. (auth)

22977 MOMENTS CALCULATIONS OF THE FERMI AGE IN MODERATORS AND MODERATOR–METAL MIXTURES. G. D. Joanou, A. J. Goodjohn, and N. F. Wikner (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nuclear Sci. and Eng., 13: 171-89(June 1962). (GA-2157)

Essentially exact calculations of Fermi age in pure moderators and in moderator–metal mixtures are performed by computing the first few moments of the slowing-down distribution. The treatment of energy degradation takes into account the anisotropy of the elastic scattering to sixth order in a Legendre expansion. Energy degradation through inelastic and (n, 2n) processes is explicitly included. (auth)

22978 EFFECTIVE DIFFUSION COEFFICIENT IN VOID REGIONS. G. Velarde (Junta de Energia Nuclear, Madrid). Nuclear Sci. and Eng., 13: 200(June 1962).

The multigroup diffusion theory for a virtually critical medium with homogeneous regions, when applied to a void region having one-dimensional cylindrical geometry, yields slightly erroneous results as a result of the fact that the theory ignores the neutron current traversing the gap. A correction factor is formulated that may be thought of as an effective diffusion coefficient for the void region (all neutron cross sections in the void region being zero). (T.F.H.)

22979 THEORY OF SLOW NEUTRON SCATTERING BY LIQUIDS. [PART] I. A. Rahman, K. S. Singwi, and A. Sjoelander (Argonne National Lab., Ill.). Phys. Rev., 126: 986-96(May 1, 1962).

Based on Van Hove's formalism, scattering in liquids is discussed. The scattering cross section is expressed in terms of velocity correlation functions; for the incoherent scattering cross section, only a knowledge of the velocity autocorrelation function $(v(0) \cdot v(t))_T$ is necessary in the Gaussian approximation for Van Hove's $G_s(r,t)$ function. The departure from the Gaussian approximation is expressed in terms of higher order velocity correlation functions. A derivation of an approximate formula for the width function of the Gaussian $G_s(r,t)$ is given. The frequency spectrum of the velocity autocorrelation function is introduced, and, as a consequence of the fluctuation-dissipation relations, the spectral representation of the width function is formally identical with that for a harmonic solid. The first few moments of the energy transfer are discussed. Some satisfy relations which involve only experimentally-observable quantities; these relations can be used to check the internal consistency of the data. (auth)

22980 STOCHASTIC MODEL OF A LIQUID AND COLD NEUTRON SCATTERING. [PART] II. A. Rahman, K. S. Singwi, and A. Sjoelander (Argonne National Lab., Ill.). Phys. Rev., 126: 997-1004(May 1, 1962).

A simple model for the atomic motions in a liquid was constructed based on the assumption that rapidly-varying motions behave similarly to those in a solid, whereas slowly varying motions behave according to Langevin's equation for diffusion. The displacement of an atom was written as a sum of statistically independent "modes." Each "mode" is assumed to obey Langevin's equation for a harmonic oscillator with a certain frequency and a certain damping. To account for diffusion, it is assumed that for "modes" below a certain frequency, the harmonic restoring force is absent and thus these "modes" obey Langevin's equation for diffusion. Van Hove's $G_s(r,t)$ function is Gaussian; its width function was calculated. The computed scattering cross section for neutrons was compared with data for water and for liquid lead. (auth)

22981 THE DIFFUSION COOLING PHENOMENON IN NON STATIONARY NEUTRON MIGRATION. Zbigniew Weiss. Postępy Tech. Jądrowej, No. 2, 183-96(1961). (PAEC-RR-3) (In Polish)

In interpreting diffusion measurements carried out with the impulse method, it was discovered that the effective coefficient of diffusion in a finite medium was different from the zero buckling case. The effect is the establishment of a neutron temperature, in dynamic equilibrium with the medium, that is lower than the temperature of the medium. This phenomenon of diffusion cooling is reviewed. The re-

view begins with the phenomenological theory of von Dardel, followed by a discussion of the role of the coefficient of diffusion cooling in impulse measurements. Both the early theory of Nelkin and his newer theory are presented. The cross section for energy transfer is discussed. After a presentation of experimental results on diffusion coefficients obtained in impulse type measurements, the monatomic heavy gas model and the heavy crystalline model of a moderator are discussed. (TTT)

22982 INELASTIC SCATTERING OF SLOW NEUTRONS ON ARBITRARY CRYSTALS AND THE GENERAL PROBLEM OF RECONSTRUCTION OF THE PHONON SPECTRUM. Yu. Kagan. Zhur. Eksptl'. i Teoret. Fiz., 42: 1375-85 (May 1962). (In Russian)

Scattering of slow neutrons on crystals of arbitrary symmetry with an arbitrary number of atoms in the elementary cell is considered. The rigorous converse problem (no model being employed) of reconstructing the phonon spectrum is analyzed. The possibility of dividing coherent and incoherent scattering is demonstrated. It is found that in order to determine the distribution function of the phonon spectrum frequencies, incoherent scattering on crystals with various isotopic compositions should be performed, the number of the latter not being smaller than the number of various atoms in an elementary cell. It is shown that the polarization vectors for arbitrary values of the wave vector in the reciprocal lattice can be determined from the results of measurement of inelastic coherent scattering (besides the dispersion law). (auth)

Nuclear Properties and Reactions

Refer also to abstracts 21908, 21909, and 21910.

22983 (AWRE-O-46/58) DETERMINATION OF ^{239}U FROM THE (n,γ) REACTION OF 14.5 Mev NEUTRONS WITH ^{238}U. L. P. O'Connor and C. A. Ridler (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). Dec. 1958. Reprinted Apr. 1962. 24p.

A method for the separation of uranium from daughter elements and fission products and the subsequent determination of uranium-239 is described. The object of the determination was the evaluation of the cross section for the reaction $U^{238}(n,\gamma)U^{239}$ at neutron energies of 14.5 Mev. The neutron flux, the time available for bombardment, and the quantity of target material which could be used were limited. For these reasons the uranium-239 separation was chosen in preference to that of its longer-lived daughter, neptunium-239. (auth)

22984 (GA-2451(Vol.I)) NUCLEAR DATA FOR GAM-1 DATA TAPE. VOLUME I. G. D. Joanou, J. S. Dudek, A. J. Goodjohn, and N. F. Wikner (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Aug. 22, 1961. Contract AT(04-3)-314. 268p.

Tabulations are presented of the multigroup cross sections incorporated on the data tape of the slowing-down code GAM-1. The energy range from 10^7 ev to 0.414 ev is divided into 68 groups of a constant lethargy, $\Delta u = 0.25$. Multigroup, absorption, and fission cross sections, the elastic and inelastic scattering matrices, and resonance parameters are provided for each isotope where appropriate. The multigroup data tabulated for each isotope are given after the identification; if a reaction occurs R = 1, if not R = 0. (M.C.G.)

22985 (NP-11747) SISTEMÁTICA DE LAS TRANSICIONES ISOMÉRICAS DEL TIPO M_4 Y EL MODELO DE LA PARTÍCULA INDEPENDIENTE EN NUCLEÍDOS DE A IMPAR. INFORME NO. 58. (Systematics of the Isomeric Transitions of the Type M_4 and the Independent Particle Model of Odd A Nuclei. Report No. 58). S. J. Nassiff and A. Mocoroa (Argentina. Comisión Nacional de Energía Atómica, Buenos Aires). 1961. 20p.

Experimental data on electromagnetic transitions of the type M_4 are systematized. The data are compared with the results predicted by the independent particle model. (tr-auth)

22986 (ORNL-3268) PHYSICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING JANUARY 31, 1962. (Oak Ridge National Lab., Tenn.). June 11, 1962. Contract W-7405-eng-26. 135p.

Progress is reported on physics research. Abstracts of 41 papers previously published are given. Separate abstracts were prepared for 20 of 28 reports of progress. (M.C.G.)

22987 (ORNL-3268(p.4-6)) ANALYSIS OF THE INELASTIC SCATTERING OF ALPHA PARTICLES. R. H. Bassel, R. M. Drisko, and G. R. Satchler (Oak Ridge National Lab., Tenn.).

The inelastic scattering of alpha particles was analyzed by using a nonspherical generalization of the optical model and the distorted-waves method. (auth)

22988 (ORNL-3268(p.8-10)) PHENOMENOLOGICAL NUCLEAR POTENTIALS FOR CLOSED-SHELL NUCLEI. J. L. Fowler (Oak Ridge National Lab., Tenn.).

The interpretation of the interaction of neutrons with the closed-shell nucleus, O^{16}, is discussed in terms of phenomenological potentials, and the analysis was extended to the case of the interaction of neutrons with Pb^{208}. (auth)

22989 (ORNL-3268(p.19-23)) DECAY OF Cs^{132}. R. L. Robinson, N. R. Johnson, and E. Eichler (Oak Ridge National Lab., Tenn.).

The gamma spectrum of Cs^{132} was studied with scintillation spectrometers. Energy-level diagrams of Xe^{132} and Ba^{132} are proposed. (auth)

22990 (ORNL-3269(p.23-40)) CHANNEL ANALYSIS OF FISSION: INTERPRETATION OF SOME EXPERIMENTAL DATA ACCORDING TO THE THEORY OF A. BOHR. R. W. Lamphere (Oak Ridge National Lab., Tenn.).

Formulas were derived to facilitate the comparison of experimentally measured fission-fragment angular distributions with theory. They are of especial significance near threshold and were applied to neutron-induced fission of U^{234}, one of the few cases where adequate data exist to admit the possibility of identifying individual fission channels. (auth)

22991 (ORNL-3268(p.43-7)) GAMMA-RAY SPECTRA FROM 30-kev NEUTRON CAPTURE. J. R. Bird, J. H. Gibbons, and W. M. Good (Oak Ridge National Lab., Tenn.).

Prompt gamma rays from 30-kev neutron capture were observed for a number of nuclides. In many cases the spectra result from capture in a single reasonance of known spin and parity. In most cases the spectra are distinctly different from results obtained by using thermal neutrons. (auth)

22992 (ORNL-3268(p.47-51)) PARAMETERS OF NEUTRON RESONANCES IN Pa^{231}. J. R. Patterson and J. A. Harvey (Oak Ridge National Lab., Tenn.).

Measurements were made of the total neutron cross section of Pa^{231} from 0.04 to 200 ev. Resonance parameters up to 100 ev, the average level spacing, the s-wave neutron strength function, the neutron width distribution, and the level-spacing distribution were derived from the data. (auth)

22993 (ORNL-3268(p.52-3)) PARAMETERS OF NEUTRON RESONANCES IN W^{184}. F. A. Khan and J. A. Harvey (Oak Ridge National Lab., Tenn.).

Neutron transmission measurements were made from 2.5 to 2000 ev on a sample of normal tungsten and one enriched in W^{184}. Parameters of nine resonances up to 1271 ev were derived from the data. (auth)

22994 (ORNL-3268(p.54-9)) FISSION FRAGMENT CORRELATION EXPERIMENTS. F. J. Walter, J. H. Neiler, R. J. Silva, and H. W. Schmitt (Oak Ridge National Lab., Tenn.).

A U^{233} thermal-neutron-induced fission fragment correlation experiment was completed. Preliminary analysis of the data showed fine structure in the mass distribution. Results and experimental techniques are discussed. (auth)

22995 (ORNL-3268(p.60-1)) HALF-LIFE OF He^6. J. K. Bienlein and Frances Pleasanton (Oak Ridge National Lab., Tenn.).

A preliminary value of $T_{\frac{1}{2}} = 0.78 \pm 0.01$ sec was obtained for the beta decay of He^6. (auth)

22996 (ORNL-3268(p.62-5)) RECOIL ENERGY AND CHARGE SPECTRA FOR THE Na^{23} IONS FORMED FROM THE β-DECAY OF Ne^{23}. T. A. Carlson (Oak Ridge National Lab., Tenn.).

Measurements were made of both the charge and recoil spectra of the sodium ions resulting from the β-decay of Ne^{23}. Less than $\frac{1}{2}\%$ deviation was noted from the expected theoretical shape for recoil energy based on the assumption that the beta-neutrino interaction is pure axial vector; while the charge spectrum can be explained in terms of multiple shake-off arising from the sudden change in nuclear charge. (auth)

22997 (ORNL-3268(p.65-7)) ELECTRON SHAKE-OFF FOLLOWING THE β^- DECAY OF Ar^{41}. T. A. Carlson (Oak Ridge National Lab., Tenn.).

Measurement of the charge spectrum of the potassium ions formed from the decay of Ar^{41} completes a series of studies on the atomic consequence of beta decay. The data are explained by a sudden nonadiabatic change in the nuclear charge followed by one or more Auger processes when inner orbital electrons are removed. (auth)

22998 (ORNL-3268(p.67-9)) MÖSSBAUER PARITY EXPERIMENT. F. E. Obenshain and H. H. Wegener (Oak Ridge National Lab., Tenn.).

A Mössbauer-parity experiment was designed to measure the sign of the ground-state magnetic moment of Ni^{61}. The relative sign of the ground and excited states is known from a previous experiment. The Mössbauer effect for Ni^{61} in the scattering position was observed by using this apparatus. (auth)

22999 (ORNL-3268(p.70-4)) A MÖSSBAUER STUDY OF THE 77-kev GAMMA TRANSITION OF Au^{197} IN A SERIES OF FERROMAGNETIC ALLOYS. THE MAGNETIC MOMENT OF THE FIRST EXCITED STATE OF Au^{197}. L. D. Roberts and J. O. Thomson (Oak Ridge National Lab., Tenn.).

The s-state density on gold was measured in the gold-nickel alloy system. This is related to the magnetic properties of these alloys and to previous theoretical considerations of this s-state density. The hyperfine structure splitting of gold dissolved in iron, cobalt, and nickel was found to be proportional to the magnetic moment of the ferromagnetic metal. The measurements are interpreted to give a magnetic moment of the first excited state of Au^{197}. (auth)

23000 (ORNL-3268(p.76-9)) INVESTIGATIONS OF PARAMAGNETIC NEUTRON SCATTERING FROM METALLIC CHROMIUM. M. K. Wilkinson, E. O. Wollan, W. C. Koehler, and J. W. Cable (Oak Ridge National Lab., Tenn.).

Neutron diffraction investigations performed on Cr^{52} indicated that localized atomic magnetic moments do not exist in metallic chromium above the Néel temperature. (auth)

23001 (ORNL-3268(p.80-1)) MAGNETIC ORDERING IN HoN. H. R. Child, M. K. Wilkinson, J. W. Cable, E. O. Wollan, and W. C. Koehler (Oak Ridge National Lab., Tenn.).

Neutron diffraction investigations on HoN in external magnetic fields helped to clarify the unusual magnetic scattering from this compound below the Curie temperature. Specific values of the ordered atomic magnetic moments were determined and a possible magnetic structure is suggested. (auth)

23002 (ORNL-3268(p.84-7)) OPTICAL PHYSICS. G. W. Charles, P. M. Griffin, H. W. Morgan, O. B. Rudolph, P. A. Staats, K. L. Vander Sluis, T. A. Welton, and G. K. Werner (Oak Ridge National Lab., Tenn.).

Preliminary work is described on the exploration of some promising two-component gas systems for optical amplification. (auth)

23003 (ORNL-3268(p.88-90)) FRAGMENT AND CHARGE SPECTRA OF THE IONS FORMED FOLLOWING RADIOACTIVE DECAY OF $C_2H_5I^{131}$ AND CH_3I^{130}. T. A. Carlson and R. M. White (Oak Ridge National Lab., Tenn.).

The fragment and charge spectra following the nuclear decay of CH_3I^{130} and $C_2H_5I^{131}$ were measured. From these data, the roles played by recoil energy and by the hydrocarbon in determining the stability of the parent xenon-hydrocarbon ion was evaluated. (auth)

23004 (ORNL-3268(p.90-94)) A 7090 PROGRAM FOR BUBBLE-CHAMBER TRACK RECONSTRUCTION. H. O. Cohn, W. M. Bugg, and R. D. McCulloch (Oak Ridge National Lab., Tenn.).

A 7090 computer program for bubble-chamber track reconstruction was written. The input is punched tape from a Hermes film measuring device. The output includes azimuth angle, dip angle, end-point coordinates, and momenta evaluated at each end of a track. (auth)

23005 (ORNL-3268(p.94-7)) RESPONSE OF SILICON SURFACE-BARRIER DETECTORS TO FISSION FRAGMENTS. H. W. Schmitt, J. H. Neiler, F. J. Walter, and R. J. Silva (Oak Ridge National Lab., Tenn.).

The response of silicon surface-barrier detectors to fission fragments was found not to be strictly proportional to fragment energy. The response is, in general, linear with a nonzero intercept. Systematics are discussed. (auth)

23006 (ORNL-3268(p.99-100)) PULSE-SHAPE CALCULATIONS FOR A LARGE LIQUID SCINTILLATOR. R. L. Macklin and J. H. Gibbons (Oak Ridge National Lab., Tenn.).

The application of Monte Carlo codes for calculating pulse-height distributions in liquid scintillators and the use of these results in pulsed Van de Graaff neutron capture studies are described. (auth)

23007 (PAN-297/I-B) PHONON DISPERSION RELATIONS FOR A COPPER SINGLE CRYSTAL IN THE [100] DIRECTION. Jerzy Sosnowski and Jan Kozubowski (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Jan. 1962. 7p.

Phonon dispersion relations for copper single crystals were investigated by means of inelastic neutron scattering. Measurements were made at room temperature by appro-

priate simultaneous variations of the incident and scattering angles using the method of successive approximations. The results are compared with those previously obtained by others. (P.C.H.)

23008 (XDC-60-8-81) PHOTON-PRODUCING AND NEUTRON ACTIVATION CROSS SECTIONS. T. D. Roberts (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). June 30, 1959. Contracts AF33(600)-38062 and AT(11-1)-171. 27p.

A tabulation of photon-producing and neutron activation cross sections is presented primarily for use in analyzing secondary gamma emission and foil activities. It is intended to supplement the information currently available. Data are included for certain cross sections of the following elements: aluminum, beryllium, copper, iron, gold, lead, manganese, oxygen, and sulfur. (auth)

23009 (XDC-61-4-35) NEUTRON CROSS SECTIONS FOR RHODIUM AND TANTALUM. Jacob W. Zwick (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Apr. 4, 1961. Contract AF33(600)-38062 and AT(11-1)-171. 45p.

Neutron cross sections of rhodium and tantalum are presented in two formats: the nineteen-level Nuclear Data Tape (NDT) structure and the twenty-five group Reactor Nuclear Data Tape (RNDT) format. The methods used in processing of the cross sections are outlined. A summary of the sources of data, available as of February 1961, is included. (auth)

23010 (AEC-tr-5128) THE COBALT (γ,p) REACTION. Miroslav Rozkoš. Translated from Czechoslov. J. Phys., 7: 592-8(1957). 10p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract no. 11389.

23011 (AEC-tr-5132) THE INDIUM (γ,p) REACTION. Miroslav Rozkoš. Translated from Czechoslov. J. Phys., 7: 20-5(1957). 9p.

The energy and angular distributions of photoprotons from indium irradiated with γ-quanta having an energy E_γ = 17.6 and 14.8 Mev were measured. On comparing the energy and angular distribution it was found that a significant part of the protons are formed during evaporation, and only about 3% of the protons are formed by a direct photoeffect. From the energy distribution the excitation energies E_g of the Cd^{114} nucleus were found to be 3.8, 4.9, 5.6, 6.3, and 7.6 Mev. (auth)

23012 (UCRL-Trans-792(L)) MEASUREMENT WITH A CRYSTAL SPECTROMETER OF SOME SOFT GAMMA LINES IN THE NEUTRON CAPTURE IN EUROPIUM. Otto Schult. Translated by Sergey Shewchuck (Univ. of California Lawrence Radiation Lab., Livermore) from Z. Physik, 158: 444-70(1960). 48p. (Includes original, 14p.).

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract no. 15337.

23013 THE ISOTOPE SHIFT EFFECT IN THE OPTICAL RADIATION OF RADIOACTIVE NUCLIDE $^{152}_{63}Eu$. Lubomir Gabła (Jagellonian Univ., Krakow). Acta Phys. Polon., 21: 305-6(1962). (In English)

The isotope shift effect in the Eu I line λ = 5765.2 A of the radioactive long-living isotope Eu^{152} was measured. Chemically pure Eu_2O_3, containing 2.9 mg of natural europium was chemically deposited in an aluminum holder and then irradiated with neutrons. The exposure time varied from 20 min. to one hr. After this time, sufficient intensity of the Eu I line λ = 5765.2 A was obtained. Because this line had no hyperfine structure splitting, the isotope shift could be measured by scanning the interference fringes registered on the photographic plate. Estimated in this way the spectroscopic quadrupole moment of the nucleus Eu^{152} was equal to 2.4×10^{-24} cm^2. (M.C.G.)

23014 NUCLEAR g-FACTOR OF THE 113 kev ROTATIONAL LEVEL IN ^{177}Hf. E. Bożek, A. Z. Hrynkiewicz, Z. Konieczny, M. Rybicka, and S. Szymczyk (Jagellonian Univ., Krakow). Acta Phys. Polon., 21: 307-9(1962). (In English)

The nuclear g-factor of the 113 kev state in Hf^{177} was measured using the method of integral angular correlation in the external magnetic field of 26300 gauss. The value 0.245 ± 0.032 was obtained. (auth)

23015 MEASUREMENTS OF THE MEAN BETA DISINTEGRATION ENERGIES OF P^{32} AND Pm^{147} AT LOW TEMPERATURES. Vaeinoe Hovi and Lasse Niemelae (Univ. of Turku, Finland). Ann. Acad. Sci. Fennicae, Ser. A, VI, No. 103, 1-10(1962). (In English)

By using an isothermal microcalorimetric method the mean beta disintegration energies of P^{32} and Pm^{147} were determined at liquid nitrogen temperatures. Taking into account the bremsstrahlung correction, the value of 691 ± 20 kev was obtained for the mean beta disintegration energy of P^{32}, in agreement with experimental data and Fermi's theory. In the case of Pm^{147} the measured mean beta disintegration energy was 70.4 ± 4 kev, about 10% higher than that obtained from the beta spectrum and the Fermi theory. (auth)

23016 CARBON, OXYGEN, AND NEON THERMONUCLEAR REACTION RATES. Hubert Reeves (Université, Montreal). Astrophys. J., 135: 779-89(May 1962).

Results obtained using the Chalk River Tandem accelerator are used to calculate the rate of thermonuclear reactions involving C, O, and Ne nuclei. The astrophysical relevance of these reactions and of the subsequent processes is discussed. (auth)

23017 PARAMETRIC ANALYSIS OF THE FISSION CROSS SECTION OF U^{235} AND U^{233} NUCLEI BY RESONANCE ENERGY RANGE NEUTRONS. I. V. Gordeev. Atomnaya Energ., 12: 408-12(May 1962). (In Russian)

Exact knowledge of the U^{235} and U^{233} cross section curves and of the radiative capture of neutrons by these nuclei in the resonance region is of great importance for nuclear reactions and reactor calculations. However, because of level interference in this region, the shape of the fission cross section curves differs from those obtained by means of the Breit-Wigner formula; on the other hand, the interference members in the radiative capture equation disappear. For this reason, the fission cross section curves of U^{235} and U^{233} and the radiative capture of neutrons by U^{235} nuclei was studied in the energy range of 0.025 to 1.5 Mev and by U^{233} nuclei in the range from 0.025 to 3 Mev, making use of V. I. Serdobol'skiĭ's theory of nuclear reactions (Zhur. Eksper. i Teoret. Fiz., 40: 590(1961)). The Doppler effect which distorts the shape of the resonance curves was not taken into account. It was found that in the most unfavorable case the lowering of the cross section at the maximum amounts to 10 to 15% which is within the limits of experimental error. The level parameters obtained were much closer to the parameters reported by D. Hughes and R. Schwartz (BNL-325, Suppl. I & II (1957-8)) than to those given by F. Shore and V. Sailor (Phys. Rev., 112: 191 (1958)). (TTT)

23018 ENERGY DISTRIBUTION OF SECONDARY ELECTRONS FROM COPPER–BERYLLIUM ALLOY BY BOMBARDMENT OF POSITIVE IONS OF INERT GASES. II. ACTIVATED COPPER–BERYLLIUM. Toshio Sugiura (Univ. of Osaka Prefecture). Bull. Chem. Soc. Japan, 35: 218-24(Feb. 1962). (In English)

The distribution curves of the kinetic energies of secondary electrons from the activated copper–beryllium surface impacted by inert gas ions were measured, together with the yield of the secondary electrons, by the retarding potential method. The contact potential difference between the activated Cu–Be target and the gold electron collector was 0.25 ev (gold, negative). The general features of the distribution curves of the secondary electrons showed a tendency similar to that of the secondary electrons emitted from electro-polished targets of Cu–Be. Results indicated that increased yields of secondary electrons by target activation depends on the stopping cross section of BeO and on the Auger process of electron omission. (M.C.G.)

23019 REMARKS ON THE NON-RADIATIVE TRANSITIONS IN MESIC ATOMS. C. William (Institut Interuniversitaire des Sciences Nucléaires, Brussels). Bull. classe sci., Acad. roy. Belg. (5), 47: 998-1008(1961). (In French)

The results of a complete calculation of the deexcitation cascade of a mesic atom recently published by Eisenberg and Kessler differ from those obtained previously. The reasons for these contradictions are given. (tr-auth)

23020 THREE-NUCLEON CONFIGURATIONS IN Pb^{207} AND Pb^{209}. H. Pollak (Centre d'Étude de l'Énergie Nucléaire (Mol-Donk), Brussels). Bull. classe sci., Acad. roy. Belg. (5), 47: 1035-45(1961). (In French)

Considering three-nucleon configurations with zero range forces, the shell model can explain five levels above 2 Mev in Pb^{207} and one in Pb^{209}. (auth)

23021 THE ISOMERIC STATE OF Po^{211}. H. Pollak (Centre d'Étude de l'Énergie Nucléaire (Mol-Donk), Brussels). Bull. classe sci., Akad. roy. Belg. (5), 47: 1046-52(1961). (In French)

By considering Po^{211} as a hard core with two external protons and a neutron, we calculate, according to the shell model, the level scheme in jj coupling with zero range forces. The ground state and first excited state have $J\pi = {}^{9}/_{2}+$. The isomeric state has $J\pi = {}^{25}/_{2}+$. These results are in agreement with experiment. (auth)

23022 RADIOACTIVE DECAY OF W^{188}. J. C. Roy (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 40: 677-86(June 1962).

The half life of W^{188} was measured to be 69.4 ± 0.5 days. The gamma radiations emitted in the decay of W^{188} were studied with a NaI scintillation spectrometer, and the beta radiations by absorption in aluminum. Three gamma rays with energies of 0.290 ± 0.005, 0.227 ± 0.005, and 0.063 ± 0.005 Mev were observed. The intensities of these gamma rays were measured relative to those of gamma rays from the daughter activity Re^{188}. The W^{188} gamma intensities thus deduced were respectively 0.002, 0.001, and about 0.001 per disintegration. The 0.227- and 0.063-Mev gamma rays were in coincidence. It was concluded that 99.3% of the beta radiations went to the ground state of Re^{188} with an energy of 0.36 ± 0.04 Mev, while about 0.4% went to an excited state at 0.290 Mev; an upper limit of 0.3% was set for a beta transition to the 0.063-Mev state. A decay scheme for W^{188} was proposed. (auth)

23023 THE PRODUCTION OF HIGH-ENERGY KNOCK-ON ELECTRONS AND BREMSSTRAHLUNG BY μ-MESONS. I. B. McDiarmid and Margaret D. Wilson (National Research Council, Ottawa). Can. J. Phys., 40: 698-705(June 1962).

A multiplate cloud chamber experiment is carried out to study the electromagnetic interactions of μ mesons in iron and lead target materials. Energetic interactions that occur inside the chamber are selected by an arrangement of plastic scintillators and Geiger counters; the total track lengths, and hence the energies, of the associated electron showers are measured by a photometric method combined with scintillator measurements. When bremsstrahlung is the dominant process, the measured production probabilities are in agreement with theory for energy transfers from about 8 to 40 Bev. When the production of knock-on electrons is the dominant process, agreement with theory is obtained for energy transfers around 4.5 Bev but only fair agreement is obtained for higher energy transfers. (auth)

23024 LIFETIME OF THE 3.85-Mev LEVEL IN C^{13}. J. J. Simpson, M. A. Clark, and A. E. Litherland (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 40: 769-74(June 1962).

The lifetime of the 3.85-Mev level in C^{13} is measured by the Doppler-shift-attenuation method and is found to be $7.5^{+3}_{-2} \times 10^{-12}$ second. This lifetime, together with the $(9.3 \times 2.0) \times 10^{-3}$ relative intensity of the E2 branch from this level, implies a strength $|M|^2 = 2$ in Weisskopf units for this transition. It is also found that the primary M2 transition to the ground level of C^{13} has $|M|^2 = 0.9$ and the E1 transition to the 3.68-Mev level has $|M|^2 = 0.01$. The measured transition strengths are compared with theoretical calculations based on the weak-coupling model. (auth)

23025 STUDY OF THE DISTRIBUTION OF THE SPACING AND THE REDUCED NEUTRON LENGTHS IN ENERGY LEVELS OF RHODIUM-104 OBTAINED BY THE INTERACTION OF SLOW NEUTRONS WITH RHODIUM-103. Pierre Ribon, André Michaudon, and Ziwan Dimitrijevic (Centre d'Études Nucléaires, Saclay, France). Compt. rend., 254: 2546-8(Apr. 2, 1962). (In French)

The first results of the analysis of the total cross section of Rh^{103} up to 370 ev gives a value of the density function $S_0 = 0.5 \pm 0.1 \times 10^{-4}$ and indicate that more than half the twenty-two resonances studied are caused by p waves. On the contrary the distribution of the spaces studied up to 800 ev is very close to the Wigner law for two populations. (tr-auth)

23026 EMISSION OF BERYLLIUM^8 NUCLEI PRODUCED IN THE INTERACTIONS OF 25-BEV PROTONS WITH THE HEAVY NUCLEI OF IONOGRAPHIC EMULSIONS. Germain Baumann, Henri Braun, and Pierre Cueer. Compt. rend., 254: 2549-51(Apr. 2, 1962). (In French)

The angular and energy distributions of 510 nuclei of Be^8, emitted in the form of two α particles in correlation in stars produced by 25-bev protons, are given. A comparison of the results with the evaporation theory shows the high-energy fragments are in excess for Li^8. (tr-auth)

23027 INTRODUCTION OF INHARMONIC TERMS IN THE STUDY OF VIBRATIONS OF SPHERICAL NUCLEI. Gisèle Espi and Georges Monsonego (Université Algiers). Compt. rend., 254: 2721-3(Apr. 9, 1962). (In French)

Rotation and time inversion invariants formed from the tensor products of these variables are added to the hamiltonian of collective variables, and these invariants are treated by perturbation development. (tr-auth)

23028 EXCITATION OF THE 7.6-Mev LEVEL OF C^{12} BY 14-Mev NEUTRONS. Robert Bouchez, Michel Dubus, Jean Duclos, Dennis Hamilton, Paul Perrin, and Pierre Quivy (Centre d'Étude Nucléaires and Universite Grenoble, France). Compt. rend., 254: 2744-6(Apr. 9, 1962). (In French)

The excitation of the 0^+ level (7.66-Mev) of C^{12} with 14-Mev neutrons, measured by time-of-flight spectrometer, was shown by (n,n′) scattering. The probability of this

excitation is 10% with respect to the 2^+ level (4.43 Mev) for a scattering angle of 22°. (tr-auth)

23029 EMISSION OF HYPERFRAGMENTS IN THE NUCLEAR INTERACTIONS OF 25-Bev PHOTONS. Adèle Burdet and Georges Philbert (Institut de Physique Nucléaire, Lyon). Compt. rend., 18: 3184-6(Apr. 30, 1962). (In French)

A study of the hyperfragments emitted in interactions of 25-Bev protons with emulsion nuclei has shown: (a) that the probability of production is higher than that observed in interactions provoked by 4.5-Bev π^- mesons; and (b) that the mean kinetic energy of the hyperfragments is low and does not sensibly depend on the energy of the primary particles. (tr-auth)

23030 FORMATION OF THE NUCLEAR ISOMERS OF SCANDIUM-44 AND COBALT-58 BY THE (α,n) REACTION. Taku Matsuo (Clark Univ., Worcester, Mass.). Dissertation Abstr., 22: 2605(Feb. 1962).

Isomeric ratios, σ_m/σ_g, for the formation of Sc^{44} and Co^{58} isomers in the (α,n) reactions were measured as a function of alpha-particle energy. The isomeric ratio of Sc^{44} is 0.3 at 6 Mev, increases to 2.0 at 26 Mev, and then decreases to 0.9 at 40 Mev. Similar behavior was observed in the study of the Co^{58} isomeric pair: 1.1 at 12 Mev, 3.4 at 20 Mev, and 1.9 at 29.5 Mev. Total cross sections for the isomeric pairs were also measured. The excitation function for Sc^{44} showed an appreciable tail in the high-energy region. Based on the energy dependence of the isomeric ratio and the total cross section, it was concluded that the isomeric pairs are formed by a compound-nucleus mechanism at an alpha-particle energy below 20 Mev and partly by a direct-interaction mechanism at higher energies. This conclusion was confirmed by measuring the recoil ranges of Sc^{44} and Co^{58}. As the alpha-particle energy was increased, the average ranges of the Sc^{44} isomeric pair became less than that of Sc^{43} which was taken to be formed by a compound-nucleus mechanism. The decrease in range was greater for the ground-state isomer. Similar behavior was observed when the average ranges of the Co^{58} isomeric pair were compared with that of Co^{57}. Calculations were made for the isomeric ratios predicted by a compound-nucleus mechanism and by a direct-interaction model. In the compound-nucleus reaction, the isomeric ratio is mainly determined by the energy of the alpha particle and the spin dependence of the level density in the residual nucleus. For a direct interaction, the spin dependence of the level density in the final product appears to be a predominant factor.

23031 ION-ATOM POTENTIAL ENERGY FUNCTIONS OBTAINED FROM kev SCATTERING DATA. George Homer Lane, Jr. (Univ. of Connecticut, Storrs). Dissertation Abstr., 22: 2838(Feb. 1962).

The potential energy functions between ions and atoms in collision were calculated using equations developed by Firsov and differential cross sections measures by Fuls, et al., and Jones, et al. The equations assumed classical, quasi-adiabatic conditions and required differential cross sections measured over a wide range of scattering angles at one incident energy. The ion-atom combinations used were Ar^+ on Ar, Ne^+ on Ar, Ne^+ on Ne, He^+ on Ar, He^+ on Ne, and He^+ on He with incident energies of 25, 50, and 100 kev. The potential energies calculated were positive, were in a range from one to sixty thousand electron volts, and corresponded to atomic separations from 0.05 to 0.4 angstroms. The incident ions penetrated inside the electronic shells of the target atoms. Experimental errors will not permit the detection of velocity dependent or inelastic processes but the resultant potential energies were found to fit very well a function derived by Firsov from a statistical model. An exponentially screened Coulomb potential energy function did not fit quite as well, but both these functions were within the accuracy of the experimental data and either could be used to calculate the forces between the ion and the atom in this energy range.

23032 THE SOFT X-RAY CONTINUOUS SPECTRUM FROM LOW ENERGY ELECTRONS IN THE 80A-180A REGION. Thomas Jefferson Patterson, Jr. (Cornell Univ., Ithaca, N. Y.). Dissertation Abstr., 22: 2838(Feb. 1962).

The intensity distributions in the low energy continuous x-ray spectrum from solid targets were studied by means of a calibrated vacuum spectrometer. The x-ray beam was incident upon a concave glass grating at a grazing angle of 4.642°, and the dispersed radiation was recorded on a photographic plate mounted along the Rowland circle. Knowledge of grating efficiency and instrumental dispersion made it possible to obtain a relative intensity distribution of the radiation emitted from the source. The target consisted of a freshly evaporated layer which was subsequently renewed at frequent intervals during exposure. Pressures below 3.0×10^{-6} mm of mercury were maintained in the x-ray tube during exposure. The experimental observations were confined to the wavelength interval extending from 80 to 180 A. The investigation indicated that the intensity per unit wavelength interval can be closely approximated by a function of the form B/λ^{α}. In particular, the values of α ranged from 1.9 for aluminum at an accelerating potential of 3.0 kv to a value of 3.0 for silver and gold at accelerating potentials of 3.0 kv. B is a normalization constant chosen for convenience to give a relative intensity of 100 at a wavelength of 80 A. Reduction of the accelerating potential below 3.0 kv resulted in a decrease in the observed value of α for both silver and manganese targets; i.e., as the observable range of wavelengtns approached the short wavelength limit, the intensity per unit wavelength interval tended toward a $1/\lambda^2$ dependence. Observation of the spectrum at various angles of photon emergence showed variations in the spectral shape which are in accordance with theory, but there appeared to be no significant evidence of the effects of self-absorption of the x-ray photons by target material. Relative intensity distributions in the continuous spectrum for a magnesium target at a potential of 675 volts and a manganese target at a potential of 630 volts agreed with the predictions of the basic Sommerfeld theory for the continuous spectrum. Published range-energy relations indicated that electrons with kinetic energies around 600 ev penetrate to a depth of less than 200 A; thus significant contributions to the spectrum come from interactions of electrons and atoms which lie essentially in the surface layers of the target. Since the theory is based upon one interaction between a given electron and a monolayer of atoms, the agreement of the experimental results with prediction indicated that use of the thin target model is applicable at these electron energies and x-ray wavelengths.

23033 STUDY OF RADIATIONS FROM HAFNIUM-172, NEODYMIUM-144, DYSPROSIUM-156, AND ERBIUM-162. Francis Joseph Bradley (Ohio State Univ., Columbus). Dissertation Abstr., 22: 2841(Feb. 1962).

The conversion electron and gamma spectra of Hf^{172} were studied in a thick lens magnetic spectrometer and multichannel analyzer. A sample was checked in a proportional counter for alpha emission with a negative result. In the thick lens spectrometer, no positron activity was detected at 300, 200, or 100 kev. The following transition energies,

from conversion electron data with relative intensities of K and L peaks in brackets, were assigned to the Hf^{172} decay: 80 (L 18): 90 (L 12): 103 (K 36, L 5): 113 (K 41, L 5): 124 (K 100, L 24): 151 (K 6, L 1): 185 (K 9) kev. The complex gamma ray spectrum was separated into its component photopeaks with the aid of the multichannel analyzer. The gamma rays and their relative intensities were Lu K-x ray (895): 80 (40): 90 (17): 113 (30): 124 (100): 152 (7): 186 (11): 240 (2): 278 (1): 317 (2): 412 (6): 496 (<1) kev. From information based on K/L ratios and gamma ray intensities the following multipolarity assignments were made: 80 : E1; 90 : M1; 103 : M1; 113 : M1; 124 : E1 + M2; 151 : E1; 185 : M1; 278 : M1; 412 : M2; 496 : E2. There is some uncertainty in the assignment of pure E1 to the 80 kev transition because of the Lu^{172} daughter growth and this transition may be a mixture of E1 + M2. The log $ft_{\frac{1}{2}}$ value, which was determined for the ground state to ground state transition in Hf^{172} decay, was 9.1. This indicated that the electron capture decay to this level was probably first forbidden. An energy level diagram for Lu^{172} based on the above spectra was formulated with a ground state assignment of nuclear spin and parity of 2(-). Energy levels were postulated at 80, 90, 124, 186, 237, 338, 412, and 496 kev. The levels at 90 and 124 kev were previously reported by Narasimhaiah and Pool for this isotope. If the coincidence data of Bowman is combined with these results the average of all data gives the following energies and intensities: Lu K x ray (510), 80 ± 1 kev (40), 89 ±1 kev (47), 103 ±2 kev (20), 113 ± 1 kev (49), 124 ± 1 kev (100), 153 ± 2 kev (5), and 188 ± 2 kev (11). The energy level diagram based on these data has levels at 80, 89, 113, 124, 153, 256, 341, 412, 498, 512, and 537 kev. To study low level alpha emission from selected rare earth isotopes, an alpha detector, based on the vibrating reed principle, was designed and built. The counting system was checked with an enriched Sm^{147} sample; a 35.1 microgram sample measured 0.61 ± 0.03 counts per minute above background. This intensity gave a half life of $1.2 \pm 0.1 \times 10^{11}$ years which compares with 1.3×10^{11} years obtained by nuclear emulsion and proportional counting techniques. The background of the alpha detector was 0.01 counts per minute in the energy intervals 1.1 to 2.7 and 2.7 to 3.7 Mev. A chemically purified sample of enriched Nd^{144} gave a half life of greater than 1.8×10^{16} years for alpha emission in the energy interval 1.2 – 2.6 Mev and a half life of 1.3×10^{16} years for alpha emission in the energy interval 2.6 to 3.4 Mev. A sample of enriched Dy^{156} which was chemically purified to free it of alpha contaminants was found to give a half life of greater than 10^{15} years for alpha emission in 1.2 to 2.6 Mev, and a half life of 2.0×10^{14} years for alpha emission in the energy interval 2.6 to 3.4 Mev. A sample of Er^{162}, which was chemically separated from possible alpha emitting contaminants, gave a half life of greater than 1.0×10^{15} years in the energy interval 1.4 to 2.9 Mev and greater than 0.9×10^{15} years in the energy interval 2.9 to 3.9. Based on these half life determinations, theoretical considerations which indicate that certain naturally occurring low mass number, rare earth isotopes have a half life of less than 10^{15} years may need to be revised.

23034 EXPERIMENTAL MEASUREMENT AND STRIPPING ANALYSIS OF $Be^9(Li^6,\alpha)B^{11}$ ANGULAR DISTRIBUTIONS. James Joseph Leigh (Univ. of Minnesota, Minneapolis). Dissertation Abstr., 22: 2842-3(Feb. 1962).

Differential cross sections of the $Be^9(Li^6,\alpha)B^{11}$ reaction were measured as a function of bombarding energy and scattering angle. The α particles leaving the B^{11} in the ground state, α_0, in the first excited state, α_1, and in the second and third excited states, $\alpha_2 + \alpha_3$, were observed at 10° intervals from 10 to 160° (lab system) at Li^6 energies of 3.00, 3.25, and 3.50 Mev, and at 20, 60, 90, 120, and 160° (center of mass system for α_0) at energies of 2.00, 2.50, 3.75, and 4.00 Mev. Detection of the α particles in the presence of the products of other reactions induced by the bombardment of Be^9 with Li^6 was facilitated by the use of a particle identification incorporating a dE/dx and E counter telescope. The angular distributions of the α_0 and α_1 groups were asymmetric about 90° cm. Relative maxima occurred at both large and small scattering angles for each of the α-particle groups, the yields at large angles being comparable to those at small angles. Relative maxima occurred also at approximately 110° center of mass system for α_0 and at approximately 80° for α_1. In all cases the angular distributions varied only slowly with bombarding energy while the yield at each angle increased monotonically with increasing energy. In going from 3.00 to 3.50 Mev the total cross sections increased by a factor of approximately two. The total cross sections at 3.50 Mev were 1.10 mb for α_0, 0.74 mb for α_1, and 2.76 mb for $\alpha_2 + \alpha_3$. The uncertainty in the absolute values of the cross sections was approximately 40%, but the relative values were determined to better than 10%. An analysis of the angular distributions was carried out using an elementary form of stripping theory, and is given in detail. Both the normal stripping mode and that exchange mode commonly called "heavy-particle stripping" were incorporated in the analysis. Coulomb effects and compound nucleus contributions were not included. The model assumed that the Li^6 and Be^9 nuclei may be represented by the two-cluster configurations "alpha particle plus deuteron" and "alpha particle plus He^5" respectively. The internal structure of the clusters was ignored, but their spins and parities were recognized. The angular distribution calculated for the α_1 group at a bombarding energy of 3.25 Mev provided a satisfactory fit to the experimental results. The theoretical angular distribution for α_0 was less successful but did show the principle features of the experimentally observed angular distribution. A discussion of several of the approximations made in the analysis is included. It was concluded that the reaction mechanism is primarily one of stripping.

23035 RESONANT ABSORPTION OF 9.9-Mev GAMMA RAYS BY Ca^{40} NUCLEI. Lakshmanan Kasturi Rangan (Univ. of Kansas, Lawrence). Dissertation Abstr., 22: 2843(Feb. 1962).

The mean lifetime τ_t of an excited state of the nucleus of Ca^{40}, attained by (p,γ) reaction in K^{39}, was measured using the resonance absorption method. The "area method" was used to connect the mean lifetime (or equivalently, the total level width Γ_t) of the state with other observable parameters. Knowledge of the total angular momentum J of the excited state, the quantity $\omega\gamma$ for the reaction, and the ground-state branching ratio of the emitted γ radiation are necessary for the calculation of τ_t. Each of these parameters was measured by performing separate experiments. The value of τ_t obtained was corrected for thermal motion of the nuclei. The corrected value of $\tau_t = (1.04 \pm 0.19) \times 10^{-16}$ sec if J = 1 and $\tau_t = (1.64 \pm 0.31) \times 10^{-16}$ sec if J = 2. These transition rates were compared with Weisskopf estimates. Agreement is good with τ_t obtained for J = 1.

23036 NUCLEAR STATES WITH HIGH ANGULAR MOMENTA AND THEIR STABILITY. Daniel Sperber (Princeton Univ., N. J.). Dissertation Abstr., 22: 2844 (Feb. 1962).

A general survey was made of the dependence of the energy of the lowest nuclear state with a specified high angular momentum on that angular momentum, based on four

different models. In addition the stability of states with high angular momenta is studied. In all applications of the shell model attention was limited to closed shell nuclei or to nuclei which are idealized to be closed shell nuclei. The calculated energy of the lowest state was found to depend approximately quadratically upon angular momentum. The constant of proportionality defined an effective moment of inertia. The moments thus found for all four models did not appreciably differ from that of a rigid body, in accord with Bloch's findings. Coulomb energy was neglected, and equal numbers of protons and neutrons were assumed. Consequently the results do not apply to heavy nuclei, where high angular momentum combined with high charge can bring about a big deformation and cause fission. The nuclei under scrutiny are considered to have cylindrical symmetry. The axis of symmetry is identified with the angular momentum vector. An expression for the equilibrium configuration for the lowest state of a nucleus with a specified angular momentum, as well as an expression for the dependence of energy on angular momentum were derived on the basis of the liquid drop model, the Fermi gas model with the nucleons moving in a square well potential with a supplementary surface tension energy proportional to the surface area of this deformed potential well, the Fermi gas model with the individual nucleons moving in a harmonic oscillator well, and the shell model with a harmonic oscillator potential. In addition, the stability of exited rotating nuclei was investigated with regard to heavy particles emission and γ radiation. Finally, a way is suggested to estimate the energy of lowest state of a specified angular momentum from observations on the density of exited states of the same angular momentum, as in experiments on slow neutron capture. In principle such slow neutron experimentation on a number of nearby nuclei of known spins should eventually allow one experimentally to determine the dependence of energy on angular momentum.

23037 RADIATIVE CORRECTIONS TO THE METASTABLE STATES OF THE HELIUM ATOM. Kiu Suk Suh (Cornell Univ., Ithaca, N. Y.). Dissertation Abstr., 22: 2844-5(Feb, 1962).

The radiative corrections of order of α^3Ry arising from the effect of quantum electrodynamics was calculated for the ionization potentials in the metastable states $(1s, 2s)^{1,3}S$ of the Helium atom. In the computation of the average excitation energy k_0 for the two electron atom, the main contribution came from the transitions to (ms, np)^{1,3}P and (ms, continuous p)^{1,3}P states, giving $\ln k_0 = 4.37$ for singlet and $\ln k_0 = 4.38$ for triplet. The radiative corrections of order of α^3Ry for the ionization potential in the $(1s,2s)^{1,3}S$ states were calculated to be $I_{\alpha^3} = -0.058$ cm^{-1} for singlet and $I_{\alpha^3} = -0.107$ cm^{-1} for triplet. The theoretical ionization potentials up to the order of α^3Ry, using Pekeris theoretical value calculated up to the order of α^2Ry, are $I_{\geq\alpha^3}$Ry = 32,033.26 cm^{-1} for singlet and $I_{\geq\alpha^3}$Ry = 38,454.721 cm^{-1} for triplet. These theoretical values are in good agreement with the experimental ionization potentials measured by Herzbert $I_{exp} = 32,033.24 \pm 0.05$ cm^{-1} for singlet and $I_{exp} = 38,454.73 \pm 0.05$ cm^{-1} for triplet.

23038 NUCLEAR MAGNETIC RESONANCE IN LIQUID HELIUM THREE. James Roland Gaines (Washington Univ., St. Louis). Dissertation Abstr., 22: 2845-6(Feb. 1962).

The spin-lattice relaxation time (T_1) was measured by pulsed magnetic resonance techniques along the vaporization curve in liquid He^3. At a Larmor frequency of 22 Mc/sec, T_1 had the value 600 sec at 3°K, decreased smoothly to 300 sec at 0.8°K, and rose to nearly 500 sec at 0.45°K. No dependence of T_1 on Larmor frequency was observed in the vicinity of this minimum. The self-diffusion coefficient (D) was measured along the vaporization curve from 3 to 1.35°K. A dependence of D on the size of the sample container was observed, indicating that artificial diffusion barriers affect a determination of the self-diffusion coefficient by spin-echo techniques. Experimental values for the nuclear susceptibility (χ) along the vaporization curve were obtained from 3 to 0.64°K. If an attempt was made to fit the data with a curve characteristic of the susceptibility of a Fermi-Dirac gas, a degeneracy temperature of $T_\theta = 0.87$°K was obtained. Measurements of the molar susceptibility as a function of pressure above 1.35°K indicated that χ (molar) decreases with increasing pressure. This can be interpreted as an antiferromagnetic ordering of the nuclear spins in the liquid at relatively high temperatures. Temperatures below 1.33°K were attained by means of a He^3 refrigerator. Carbon resistors calibrated against the saturated vapor pressure of both He^3 and He^4 were used as thermometers down to 0.45°K.

23039 PROTON-GAMMA ANGULAR CORRELATIONS: THE $C^{12}(d,p)$ REACTION. Neil Russel Fletcher (Duke Univ., Durham, N. C.). Dissertation Abstr., 22: 4053-4 (May 1962).

Angular correlations between protons and gamma rays from the $C^{12}(d,p\gamma)C^{13}$ reaction were measured through the first three excited states of C^{13} in an attempt to verify the predictions of the distorted wave stripping theory and to determine the multipole mixtures of some of the de-excitation gamma rays. The orbital angular momenta of the neutrons captured into the first, second, and third excited states of C^{13} are $l_n = 0$, 1, and 2 respectively. A target of natural carbon was bombarded by deuterons from a 4-Mev Van de Graaff and the charged particle reaction products were analyzed by a momentum spectrometer. Proton-gamma coincidences were counted by the use of scintillation counters and a fast-slow coincidence circuit with $2\tau \sim 2(10)^{-8}$ sec. In general the correlations exhibit both front-back and left-right symmetry with respect to an axis shifted from the C^{13} recoil axis, which indicates a direct interaction with some distortion of deuteron and proton waves. The correlation through the first excited state of C^{13} was observed at a laboratory scattering angle (θ_{dp}) of 20° and deuteron energy of $E_d = 2.80$ Mev and was shown to be isotropic in both the reaction plane and the azimuthal plane. The correlation through the second excited state was measured at $\theta_{dp} = 20°$ and $E_d = 3.70$, 3.23, and 2.80 Mev, and showed decreasing anisotropy with decreasing bombarding energy. This correlation was also studied at $E_d = 3.23$ Mev and $\theta_{dp} = 40°$, 60°, 80°, 110°, and 150°. Both the anisotropy of the correlation and the symmetry axis shift varied greatly for different proton scattering angles. P_2-γ azimuthal correlations were also observed for all the above energy-angle combinations and in all but one case the sign of the anisotropy was opposite that predicted by the distorted wave theory. The angular correlation through the third excited state measured at $\theta_{dp} = 40°$ was shown to be energy independent for the three bombarding energies used and exhibited both axial symmetry and front-back symmetry about an axis shifted from the recoil direction. These features indicated little distortion in the formation of the 3.85-Mev state of C^{13} and therefore the p_3-γ correlation was used to determine the multipole mixtures of $\Gamma_\gamma(E3)/\Gamma_\gamma(M2) \leq 10^{-3}$ for the 3.85-Mev radiation and $0.05 \leq \Gamma_\gamma(E2)/\Gamma_\gamma(M1) \leq 1.0$ for the 3.68-Mev radiation by application of the simple Butler theory with shifted symmetry axis. The different distortions present in the formation of the second and third excited states must be a different distortion of proton waves scattered and absorbed

by the excited states of C^{13} and it suggests the practicality of studying potentials of excited states in light nuclei by this type reaction.

23040 A STUDY OF PARTICLE EMISSION FROM A ROTATING NUCLEUS. Charles Ray Gruhn (Univ. of Washington). Dissertation Abstr., 22: 4054(May 1962).

Particle emission from a rotating nucleus was studied through the angular correlations of pairs of evaporated protons. The pairs of protons were emitted from compound nuclei formed by bombarding Ni^{58} with alpha particles having incident energies of 27, 32, and 42 Mev. The emitted coincident protons were studied in scintillation counter telescopes. The proton spectra were measured from 2.2 to 15 Mev at a number of pairs of angles. The angular correlation study involved three types of angular distributions, two of which were taken in a plane containing the beam, and third in a plane perpendicular to the beam. The data were interpreted in terms of a classical evaporation model which characterizes the angular dependence of the emission process with a single parameter of x_{av}. In terms of this model, the measured value was 0.39 ± 0.04. It was also possible to measure the product $x_1 \cdot x_2$. Here the subscripts refer to successive evaporated protons. The result was $x_1 \cdot x_2 = 0.10 \pm 0.03$. From an examination of the measured x values it was concluded that the average of the ratio, I_{CN}/I_{rigid}, is less than unity but it was difficult to determine whether this ratio was dependent on excitation energy.

23041 RADIOACTIVE DECAY OF $Os^{188} + \alpha$. Wilson William Kalyan-Masih (Ohio State Univ., Columbus). Dissertation Abstr., 22: 4054-5(May 1962).

Osmium enriched to 87.7% in the mass number 188 was irradiated by 24 Mev α-particles. Subsequent to an (α,n) reaction $_{78}Pt^{191}$ was produced, which decayed to $_{77}Ir^{191}$ mainly by electron capture. The Z number 77 and the A number 191 were assigned to the gamma activity of the sample by comparing the x ray emitted by it and by correlating the half life and gamma transitions observed by other investigators. The decay of the sample was followed for about four months. A common half life of 2.89 days was obtained for the 64.5, 95.8, 129.6, 176.0, 220.0, 268.4, 360.0, 410.0, 539.0, and 626.0 kev photopeaks of the sample. The standard sources Ba^{133}, Cs^{137}, Na^{22}, Co^{57}, Co^{60}, Zn^{65}, and Cr^{51} were used to obtain spectra of the sample. Gain checks revealed that the possible shift was not over half a channel. Since the linear energy calibration was such that one channel corresponded to 4.32 kev, the values of the gamma transitions were determined correct within ± 2.2 kev. The spectral shapes of 176.0, 360.0, and 539.0 kev peaks were not quite Gaussian, and it was apparent that these were composite peaks. Since the 220.0 kev peak was quite weak, it was impossible to determine by visual inspection whether it was composite or single. Unscrambling and coincidence studies revealed that these were all composite peaks. When these views were taken into consideration in all 17 gamma transitions, 64.5, 95.8, 129.6, 172.6, 178.4, 188.6, 219.7, 221.4, 268.4, 351.0, 361.2, 410.0, 457.0, 496.4, 539.6, 570.7, and 626.0 kev were determined within ± 2.2 kev. Unscrambling studies revealed that the ratios of the relative intensities were as follows: 65 : 96 : 129 : 176 : 220 : 268 : 360 : 410 : 457 : 539 : 626 : : 52.0 : 1.3 : 3.3 : 2.2 : 0.1 : 1.1 : 9.5 : 5.7 : 2.9 : 19.3 : 2.7. Gamma-gamma coincidence studies provided the following coincidence relations: (129γ)(172γ, 188γ, 219γ, 221γ, 361γ, 410γ, and 496γ), (178γ)(172γ, 188γ, 219γ, and 361γ), (172γ)(96γ, 129γ, 178γ, 188γ, and 219γ), (188γ)(96γ, 129γ, 172γ, 178γ, and 351γ), (268γ)(188γ and 219γ), (351γ)(188γ and 219γ), (361γ)(96γ, 129γ, and 178γ), and (410γ)(129γ). The 539, 570, and 626 kev photopeaks were not found in coincidence with any other gamma. Two gamma transitions, 82.6 and 48.8 kev, are heavily internally converted. Transition probabilities were calculated by using the available conversion electron data (theoretical and experimental). Multipole orders were also assigned on the basis of the experimental data to the various gamma transitions detected. An energy level diagram was proposed which was consistent with all the coincidence measurements, transition probabilities, and multipole orders assigned to the gamma transitions of $Os^{188} + \alpha$.

23042 STUDIES OF NUCLEI WITH THE COLLECTIVE MODEL OF THE NUCLEUS AND INTERMEDIATE COUPLING. Robert Francis Redmond (Ohio State Univ., Columbus). Dissertation Abstr., 22: 4055-6(May 1962).

The collective model was used to obtain theoretical predictions about the level structure, half lives of excited states, magnetic dipole moments, and direct neutron capture cross sections. The theoretical expressions for the M1 and E2 transition operators were derived and the theory of the collective motion was considered to elucidate the angular momentum properties of the collective motion. Theoretical expressions were derived for the direct neutron capture process. As an example, detailed calculations for the Te^{123} plus a neutron system were performed. The results of these calculations were in reasonably good agreement with the available experimental data, and the agreement could be improved by assuming a stronger coupling. It was found that the small B(E2) reduced transition probability observed for the first excited state in Te^{122} can be explained by a cancellation effect in the E2 transition probability. The direct neutron capture process is found to be strongly favored for direct transitions which lead to a low lying level in the product nucleus.

23043 THE INELASTIC SCATTERING OF MEDIUM-ENERGY PROJECTILES. Ernest Stephan Rost (Univ. of Pittsburgh). Dissertation Abstr., 22: 4056(May 1962).

The inelastic scattering of medium-energy projectiles was investigated on a direct interaction model using the distorted wave Born approximation. The theory was formulated so as to separate the model-independent features from those which depend sensitively on the nuclear structure model. The nuclear structure information is expressed in terms of a form factor and several form factors were derived for different models. The dynamical features of the reaction are contained in optical potentials which are taken to be those which fit the elastic scattering data. The calculations then contain only a very limited number of parameters and unique predictions are possible. Some qualitative and quantitative justifications for the use of elastic-scattering optical potentials are presented. The distorted waves theory was applied to the inelastic scattering of alpha particles by even-even nuclei using a simplified model to obtain the form factor. This model treats the transition between collective levels as being due to a non-spherical optical potential. The effect of Coulomb excitation is included. An investigation of the angular distribution resulting from the excitation of different levels of a nucleus indicated a "phase rule" relationship for strongly absorbing nuclei. Comparison was made to a few representative experiments and good agreement was found. The strength of the inelastic scattering is expressed in terms of a deformation parameter. These parameters were obtained for the (α,α') reactions and are compared to the usual deformation parameters obtained from electromagnetic excitation. The (α,α') values were found to be comparable to the electromagnetic values although the latter are generally somewhat larger. The distorted waves

theory was also applied to the 18-Mev, $Mg^{24}(p,p')$ (Q = −1.37 Mev) reaction. It was found that the magnitude of the cross section could not be explained by any reasonable single-particle or surface-interaction model. However, a more complete interpretation using Nilsson wave functions and a sum of two-body interactions proved to be successful in fitting the magnitude, as well as the general features of the angular distribution. The effect of collective features in the nuclear states was very important in explaining the magnitude of the cross section.

23044 THE EFFECT OF MAGNETIC INTERACTIONS ON THE NUCLEAR ORIENTATION OF COBALT-60 IN RARE EARTH DOUBLE NITRATES. Mark Wolf Levi (Univ. of Kansas). Dissertation Abstr., 22: 4058-9(May 1962).

Co^{60} was oriented in a spherical single crystal of $Ce_2Zn_3(NO_3)_{12}^6$ 24 H_2O cooled below one degree Kelvin by adiabatic demagnetization. The results were accounted for by postulating an internal magnetic field produced by the cerium ions and acting on the cobalt ions. The effect of the magnetic interactions, in zero applied field, was to produce a reduction in the gamma anisotropy at temperatures below 6.9 millidegrees, which is the critical temperature for magnetic ordering of the cerium ions. A maximum internal field of 165 oersted, in the molecular field approximation, gave a quantitative explanation of the data. The same isotope was also oriented in a layer of diamagnetic $La_2Zn_3(NO_3)_{12}^6$ 24 H_2O contained in a spherical crystal of cerium–zinc nitrate. The results were consistent with the theoretical calculations which neglect magnetic interactions.

23045 STUDIES ON RADIOACTIVATION BY A COBALT-60 γ-RAY SOURCE. I. GENERAL CONSIDERATIONS ON THE RADIOACTIVATION BY THE USE OF A γ-RAY SOURCE. Kenji Yoshihana. Dôitai to Hôshasen, 3: 276-85(Sept. 1960).

The principles of the reactions using artificial γ-ray sources, such as Rh^{103}, Ag^{107} or Ag^{109}, Cd^{111}, and In^{115} are discussed based on the Compton scattering theory. The estimation of the resonance flux and over-all cross section of a nuclide for radioactivation is discussed mathematically. (OID)

23046 A STUDY OF SECONDARY PROCESSES CAUSED BY FAST NEUTRAL ATOMS OF THE ALKALI METALS. U. A. Arifov, D. D. Gruich, Kh. Mirrakhimov, and S. Z. Muzhavirov (Inst. of Nuclear Physics, Academy of Sciences, Uzbek SSR). Doklady Akad. Nauk S.S.S.R., 143: 69-71 (Mar. 1, 1962). (In Russian)

Fast neutral sodium atoms were obtained by evaporating sodium into a perpendicular beam of Na^+ ions, and were allowed to hit a 10 × 10 mm Ta target surrounded with a semispherical collector in a vacuum of 5×10^{-7} mm Hg std. The intensity of fast neutral Na atoms was determined from the difference in ion currents obtained in measuring the beam with and without a shield. Oscillograms are presented for the interaction of 1250 ev sodium atoms with a tantalum target. A saw-toothed voltage of 150 ev was applied between the Ta target and the collector, and oscillograms were taken at equal time intervals with a movie camera during bombardment of the Ta target with fast Na atoms. Secondary positive ion emission of high energy is first observed. Then, as the target becomes covered with a film of alkali metal, secondary electrons and negative ions are observed. The number of secondary scattered Na^+ ions is given as a function of the energy of the fast neutral sodium atom from 1500 to 2500 ev. The yield of secondary positive ions is greater on bombarding a target with neutral atoms than it is on bombarding the target with positive ions of the metal. (TTT)

23047 A NEW METHOD FOR FAST FISSION EFFECT MEASUREMENT. F. Accinni (Centro Informazioni Studi Esperienze, Milan), S. Terrani, and G. B. Zorzoli. Energia nucleare (Milan), 9: 272-7(May 1962). (In English)

A method for fast fission effect measurement, avoiding the use of uranium at two different isotopic compositions, is described. A set of measurements, performed on the CESNEF's reactor, leading to results in good agreement with former experiments, is also reported. (auth)

23048 MOMENTUM DISTRIBUTION FOR DEUTERON CLUSTERS IN Li^6. J. Strnad (Univ. of Ljubljana, Yugoslavia). Experientia, 18: 210-11(1962). (In English)

The momentum distribution for deuteron clusters in Li^6 was calculated by means of a simple cluster model and compared with experimental data from the reaction $Li^6(p,pd)He^4$. The agreement appeared to be nearly satisfactory. (M.C.G.)

23049 ELECTRON POLARIZATION IN ELECTRON SCATTERING ON NUCLEI. V. M. Arutyunyan (Inst. of Physics, Academy of Sciences, Armenian SSR). Izvest. Akad. Nauk Armyan. S.S.R., Ser. Fiz.-Mat. Nauk, 14: No. 6, 93-8(1961). (In Russian)

Azimuthal asymmetry in the angular distribution of Mott scattering (approximation of two-amplitude double-electron scattering) was analyzed considering nuclear charge screening by atomic electrons, structural nuclear properties, and corrections to Mott's formula. It is postulated that the observed deviations from the calculated magnitude $\Delta(\theta)$ (at low energies) are related to the depolarizing effect of exchange scattering on atomic electrons. (R.V.J.)

23050 PRODUCTION OF ANTINUCLEONS IN NUCLEON AND DEUTERON REACTIONS WITH H, D^2, He^3 AND He^4. N. V. Dushin (Leningrad Polytechnic Inst.). Izvest. Vysshikh Ucheb. Zavedenĭ, Fiz., No. 2, 44-6(1962). (In Russian)

Isotropic inequalities between cross sections of various processes for antinucleon production in nucleon and deuteron reactions with H_1, D_2, He_3, and He_4 were derived. (tr-auth)

23051 ENERGY LEVELS OF B^{10} FROM $B^9(p,\gamma)B^{10}$ REACTION. Tahir Husain (Government Coll., Lahore, West Pakistan). J. Nat. Sci. and Math., 2: No. 1, 1-12(Apr. 1962). (In English)

Proton capture by Be^9 exhibits a resonance at 336 kev. The entire gamma spectrum from the $Be^9(p,\gamma)B^{10}$ reaction at 336 kev resonance was studied using single-crystal and three-crystal-pair spectrometers. The gamma rays were fitted in the energy level scheme of B^{10} nucleus. Spins and parities were assigned to the levels. (auth)

23052 NUCLEAR REACTIONS WITH SIMULTANEOUS EMISSION OF THREE BODIES. Cao Xuan Chuan (Office de l'Énergie Atomique, Saigon, France). J. phys. radium, 23: 78-80(Feb. 1962). (In French)

The distribution function $f_n(E_a,\mu)$ can be obtained by simple geometrical considerations in the general case of nuclear reactions with simultaneous emission of three particles, where the three particles are emitted in any direction. (auth)

23053 COMPARISON OF THE CROSS SECTION OF (p,n) AND (p,pn) REACTIONS INDUCED BY 30 TO 150 Mev PROTONS ON THORIUM. M. Lefort, G. N. Simonoff, and X. Tarrago (Laboratoire Joliot-Curie de Physique Nucleaire, Orsay, France). J. phys. radium, 23: 123-7(Feb. 1962). (In French)

During a study on nuclear reactions produced by protons at 30 to 150 Mev on Th, a large disproportionation between

the cross sections of $Th^{232}(p,pn)Th^{231}$ and $Th^{232}(p,n)Pa^{232}$ was observed. The cross sections were calculated at 40, 82, and 150 Mev by supposing two possible mechanisms; direct interaction of the incident proton with a neutron and emission of the proton and neutron, and neutron evaporation from incident proton release of excitation energy. The experimental and calculated results are tabulated. The reasons for the discrepancies between the two sets of values are discussed. (J.S.R.)

23054 EXCITED LEVELS OF Sn^{116}. E. Creutz, L. Grenacs, and A. Jones (Université, Louvain, France). J. phys. radium, 23: 137-44(Mar. 1962). (In French)

Measurements are made of certain angular correlations and several internal conversions. It is possible to determine angular moments and parities of the upper levels in the β^- disintegration of In^{116}. An explanation is offered for the measurements of the 2.12 Mev–0.42 Mev $\gamma\gamma$ angular correlation. By internal conversion the mixing ratio (M_1/E_2) of the 0.8-Mev transition from the second 2+ level is determined. The K/L ratio linked to the 1298-kev transition is in accordance with the theoretical value. (auth)

23055 CONTRIBUTION TO THE STUDY OF DOUBLE INDIRECT PICKUP: MEASUREMENT OF TRITIUM PRODUCTION BY 82- AND 105-Mev PROTONS ON SEVERAL TARGETS. Colette Brun, Marc Lefort, and Xavier Tarrago (Laboratoire Joliot-Curie de Physique Nucleaire, Paris). J. phys. radium, 23: 167-72(Mar. 1962). (In French)

Tritium production was measured in carbon, aluminum, iron, tin, gold, and thorium targets. The relation between cross section and $A^{\frac{5}{3}}$ was found to be linear, with absolute values of 6.5 ± 1 mb for carbon, 12 ± 1.5 mb for Al, and 40 ± 5 mb for gold and thorium. A large part of the tritons was emitted in a forward direction by a secondary "pick-up" reaction. A spectrum was built up for these tritons. Ratios of the number of tritons to "prompt" protons were calculated for gold nuclei; one proton out of 15 picked up two neutrons on nuclear boundaries in the range 15 to 42 Mev. (auth)

23056 SCATTERING AND POLARIZATION OF 57-Mev PROTONS. Shotaro Yamabe (Osaka Univ.), Minoru Takeda, Michiya Kondo, Syohei Kato, Takashi Yamazaki, Noriaki Takahashi, Nawoyuki Kawai, and Ren Chiba. J. Phys. Soc. Japan, 17: 729-35(May 1962). (In English)

The angular distributions of elastically scattered protons, for fifteen elements at 57 Mev and for two elements at 52 Mev, were measured. For some of these elements the left-right asymmetries of double scattering were also measured. (auth)

23057 PHOTOPROTON CROSS SECTIONS FOR Mg, Al, Si AND S. Katsufusa Shoda, Ken Abe, Takeo Ishizuka, Nobuaki Kawamura, and Motoharu Kimura (Tohoku Univ., Sendai). J. Phys. Soc. Japan, 17: 735-45(May 1962). (In English)

Photoproton cross sections for Mg, Al^{27}, Si^{28}, and S^{32} are measured using a betatron. A vacuum chamber with six detectors, each of which consists of a ZnS(Ag) scintillator and a photomultiplier, is used for photoproton detection. Protons having energies larger than about 1.5 Mev are measured. The obtained yield curves are converted into the cross sections by the Penfold-Leiss method. The results are as follows: the giant resonance energies are 20, 20, 19.7, and 19.3 Mev for Mg, Al^{27}, Si^{28}, and S^{32} respectively; the widths at half maximum are 6, 7, 4, and 6 Mev respectively; and the integrated cross sections up to 23 Mev are 0.070, 0.11, 0.14, and 0.26 Mev-barns respectively. (auth)

23058 THEORY OF NUCLEAR SURFACE ON THE BASIS OF THE FERMI GAS MODEL. Akira Sugiyama and Tutomu Inoue (Nagoya Technical Coll., Japan). J. Phys. Soc. Japan, 17: 759-66(May 1962). (In English)

The theory of the surface of a free-electron metal is applied to the nuclear surface, and expressions for the energy and effective position of the nuclear surface are obtained in terms of the phase shift of free nucleon waves. The expressions obtained have the following properties: the expression for surface energy is equivalent to that of Swiatecki in the one-particle approximation; the expressions are reduced to those of the Thomas-Fermi approximation when the phase shift is calculated to the first approximation of the WKB method; and the expressions serve as a test for the validity of some improved formulae in the Thomas-Fermi approximation. The calculated surface energy for a potential barrier with reasonable thickness is less than the half of the empirical surface energy, almost independently of the details of the potential. (auth)

23059 RADIOCHEMICAL INVESTIGATIONS OF THE MULTIPLE FISSION OF URANIUM. I. DETECTION OF FAST α PARTICLES WITH THE NUCLEAR REACTION $Fe^{54}(\alpha,n)Ni^{57}$. R. Muenze and O. Hladik (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Kernenergie, 5: 158-65 (Mar. 1962). (In German)

By isolating Ni^{57} in U–Fe alloys, the detection of highly energetic α particles could be deduced as products of a multiple fission of U^{235} with neutrons. The fission frequency lies in the same order of magnitude as was found in nuclear plate experiments and measurements with double ionization chambers. (tr-auth)

23060 THE EXCITATION FUNCTION OF THE $Li^7(\gamma,p)He^6$ REACTION. A. G. Gregory, T. R. Sherwood, and E. W. Titterton (Australian National Univ., Canberra). Nuclear Phys., 32: 543-52(May 1962). (In English)

Four measurements of the excitation function of the reaction $Li^7(\gamma,p)He^6$ show major disagreements. That of Rubin and Walter indicates a splitting of the resonance. The excitation function is measured at 10 to 32 Mev, and the integrated cross-section to 34 Mev is (14.6 ± 3.4) Mev × mb. No major structure is observed in the shape of the activation curve, indicating a broad resonance with appreciable cross sections up to the maximum energy investigated. (auth)

23061 MATRIX ELEMENTS OF THE FORBIDDEN β TRANSITIONS FOR DEFORMED ATOMIC NUCLEI. D. Bogdan (Inst. for Atomic Physics, Bucharest). Nuclear Phys., 32: 553-62(May 1962). (In English)

Expressions for the reduced matrix elements corresponding to the first forbidden β transitions were derived, assuming V-A type interactions and using the Nilsson single-particle model. For the relativistic operators, nonrelativistic expressions were used. Study is made of the first forbidden β transition in the decay scheme $1(\beta)2(\gamma)0$. For Re^{186}, the ξ approximation is not valid, as a result of the cancellation effect. For Tm^{170}, vanishing values for the Kotani nuclear parameters are obtained. (auth)

23062 LIFETIME OF THE 2.083 Mev STATE IN Ce^{140}. W. M. Currie (Univ. of Glasgow). Nuclear Phys., 32: 574-83(May 1962). (In English)

By delayed coincidence methods, it is shown that the 2.083-Mev level of Ce^{140} following the β-decay of La^{140} has a mean life of $(4.97 \pm 0.09) \times 10^{-9}$ sec. This is 17 times longer than the single-particle estimate. The result is considered in relation to other data on quadrupole transition probabilities, and a diagram of comparative E2 lifetimes between N = 82 and N = 126 is given. (auth)

23063 THE $Ne^{22}(p,\gamma)Na^{23}$ REACTION AND THE ENERGY LEVELS OF Na^{23}. D. W. Braben, L. L. Green, and J. C. Willmott (Univ. of Liverpool). Nuclear Phys., 32: 584-609 (May 1962). (In English)

The $Ne^{22}(p,\gamma)Na^{23}$ reaction was studied at five resonances, at 400 to 1030 kev. Spins and parities of low-lying states were determined. Results were interpreted in terms of the unified model, which gives a fair description of the observed level scheme and measured branching ratios up to about 5 Mev excitation, using three bands with $K = \frac{1}{2}, \frac{3}{2}$, and $\frac{5}{2}$. (auth)

23064 THE INTERACTION OF NEUTRONS WITH SODIUM IN THE ENERGY RANGE 0.5 TO 4 Mev. J. H. Towle and W. B. Gilboy (Atomic Weapons Research Establishment, Aldermaston, Berks., Eng.). Nuclear Phys., 32: 610-36 (May 1962). (In English)

The total neutron cross section of Na^{23} was measured at 0.8 to 4.0 Mev, and the inelastic scattering cross section from 0.5 to 2.0 Mev. Differential cross sections are given for elastic and inelastic scattering at 0.98, 1.50, 2.515, and 3.97 Mev. At 1.50 Mev, the angular distribution of the 0.44-Mev γ-rays was obtained. The data at 3.97 Mev compare satisfactorily with predictions of the optical model and Hauser-Feshbach theories, and inference on the possible spins of the 2.39 and 2.64-Mev levels was made. (auth)

23065 COULOMB EXCITATION OF THE FIRST 2^+ STATE OF EVEN NUCLEI WITH $58 \leq A \leq 82$. P. H. Stelson and F. K. McGowan (Oak Ridge National Lab., Tenn.). Nuclear Phys., 32: 652-68 (May 1962). (In English)

Gamma yields from Coulomb excitation were measured for 15 even nuclei of Ni, Zn, Ge, and Se. Coulomb excitation was produced by variable energy α particles (3 to 10 Mev). In favorable cases the absolute γ-ray yields are determined to an accuracy of $\pm 4\%$. The reduced electric quadrupole transition probabilities B(E2) are generally determined to an accuracy of $\pm 9\%$. The observed values for B(E2) are larger than the single-particle estimate by factors ranging from 11 for Ni^{58} to 51 for Se^{76}. The 2^+ energies and B(E2) values are interpreted in terms of the collective vibrational model. (auth)

23066 ON THE DECAY OF Te^{119m} AND Te^{119}. R. K. Gupta, G. C. Pramila, and R. Srinivasa Raghavan (Tata Inst. of Fundamental Research, Bombay). Nuclear Phys., 32: 669-83 (May 1962). (In English)

Radiations from 4.5-day Te^{119m} ($11/2-$) and 16 hr Te^{119} ($1/2+$), produced by 100-Mev proton bombardment of Sb, were investigated by scintillation techniques. The gamma-rays of 153, 270, (780 ± 20), (920 ± 20), (1000 ± 20), (1100 ± 20), (1220 ± 20), (1500 ± 30), (1780 ± 30), (1900 ± 30), and (2100 ± 20) kev, belonging to the decay of Te^{119m}, and gamma-rays of (645 ± 10) and (1760 ± 20) kev, associated with the decay of Te^{119}, were detected. The summing and coincidence studies show levels at 270, 645, 1220, 1370, 1760, 2150, 2220, 2290, and 2370 kev in Sb^{119} fed from Te^{119m} and Te^{119}. A $g_{\frac{1}{2}}$ assignment for the 270-kev level, expected from systematics, agrees with the data. Spin and parity assignments based on the experimental data are made for different levels. A decay scheme is suggested. (auth)

23067 SCATTERING OF 27.7 Mev DEUTERONS ON BERYLLIUM AND BORON. R. J. Slobodrian (Comisión Nacional de Energia Atómica, Buenos Aires). Nuclear Phys., 32: 684-94 (May 1962). (In English)

Beryllium and natural boron targets were bombarded by 27.7-Mev deuterons. The outgoing particles were analyzed using a scintillation spectrometer. The absolute differential cross section for the elastic scattering was measured. The resulting angular distributions exhibit the usual diffraction pattern. Employing an optical analogy, interaction radii were calculated for the deuteron-nucleus system. The results are: $R_{DN} = 4.56$ Fermi for beryllium and $R_{DN} = 5.65$ Fermi for boron. The angular distribution of the inelastic process $Be^9(d,d')Be^{9*}$ at 2.43 Mev was obtained and fitted with a direct reaction curve, using the theory of Huby and Newns, of $l = 2$ and $\alpha = 4.8$ Fermi, where l is the angular momentum change and α is the interaction radius. The ground state of Be^9 is $\frac{3}{2}$ odd, and results yield for the 2.43-Mev level an odd parity assignment, together with the possible spin values: $\frac{1}{2}, \frac{3}{2}, \frac{5}{2}$, and $\frac{7}{2}$. Better agreement with the experimental results is obtained by adding a theoretical curve of $l = 0$ with $\alpha = 4.0$ Fermi, implying the presence of deuteron spin-flip. No significant inelastic process was observed using the natural boron target (18.8% B^{10} and 81.2% B^{11}). (auth)

23068 THE PHOTODEUTERON REACTION. V. A. Madsen and E. M. Henley (Univ. of Washington, Seattle). Nuclear Phys., 33: 1-35 (May 1962). (In English)

Mechanisms for photoemission of deuterons are investigated for gamma below 45 Mev. A theoretical formulation is developed for the direct photoemission of deuterons. This treatment takes into account the finite size of the deuteron; the direct electric dipole emission of deuterons is possible even for self-conjugate nuclei for which a point deuteron has no dipole moment. Under the assumption of a single particle model for nuclear wave functions, the expression for the transition matrix element reduces to a relatively simple calculable form. For self-conjugate nuclei, the dominant direct ejection process can be described qualitatively as excitation of a single nucleon followed by a pickup reaction. Interference effects between neutrons and protons are important and reduce the cross section to be in accord with experiments. They usually cause the angular distribution of directly ejected deuterons to be peaked forwards (and backwards) rather than at 90°. Numerical calculations for the direct process were carried out for Be^9, C^{12}, O^{16}, and S^{32}, with the inclusion of quadrupole matrix elements that usually cause the angular distribution to be more peaked in the forward direction. The compound nucleus photoejection mechanism for deuterons was investigated; numerical results were computed for Cu and for S^{32}. The magnitude of the possible contributions were compared for S^{32}, for which a confrontation with experimental information is also carried out. (auth)

23069 HALF-LIFE AND HIGH-ENERGY POSITON END POINT OF Sc^{40}. Felix Schweizer and J. Reginald Richardson (Univ. of California, Los Angeles). Nuclear Phys., 33: 47-51 (May 1962). (In English)

The half life of Sc^{40}, obtained from integral decay curves for the gamma radiation, is 0.179 ± 0.002 sec. The end point of the high-energy positron spectrum, determined using a 180° uniform-field magnetic spectrometer, is 9.2 ± 0.2 Mev. The half life of this positron group agrees with that of the gamma ray. Evidence confirms the assignment and decay scheme proposed by Glass and Richardson. (auth)

23070 THE CONSTRUCTION OF WAVE FUNCTIONS FOR Li^6. L. Cohen (Univ. of Southampton, Eng.). Nuclear Phys., 33: 52-62 (May 1962). (In English)

The construction of wave functions for Li^6 is carried out by an extension of methods for the triton and the alpha particle. Cartesian tensors are used, and the cartesian analogues of vector coupling coefficients are defined. Spin

(and isobaric spin) functions are obtained in terms of spin (and isobaric spin) tensors, and their behavior under permutations is exhibited. Orbital angular momentum functions are obtained in terms of "simple" cartesian space tensors, and these are coupled with the spin-charge functions to produce eigenfunctions of total angular momentum. The behavior of these total angular momentum eigenfunctions under permutations is obtained using coupling coefficients for the symmetric group; they are then combined with scalar (space) functions of adjoint symmetry to produce totally antisymmetric functions. (auth)

23071 FRAGMENT MASS-ANGLE CORRELATION IN U^{238} + n FISSION. J. H. Manley (Los Alamos Scientific Lab., N. Mex.). Nuclear Phys., 33: 70-82(May 1962). (In English)

The $U^{238}(n,f)$ process was investigated at 1.2 to 1.7 Mev. A photographic emulsion technique was used to identify individual fragments and their angular distribution for different range-ratio groups. The fraction of total fissions in each group was independent of neutron energy. The angular distributions of all groups agree with measurements without mass discrimination except for the most nearly equal fragment group. The data suggest that this group has a larger but less energy-dependent anisotropy than other groups. (auth)

23072 LANDAU'S EQUATION FOR THE ALPHA DECAY INTENSITIES. Yatendra Pal Varshni (National Research Council, Ottawa). Nuclear Phys., 33: 83-95(May 1962). (In English)

Landau's equation for the alpha decay intensities is discussed. The ratio of the intensities of transitions to the 2+ level and the ground state W_2/W_0 shows a systematic variation with the neutron number N. The reciprocal of the "reduced hindrance factor" shows a similar behavior. The available evidence for a "subshell" at N = 136 is summarized and discussed. The calculated results, by Landau's equation, for transitions to 4+ levels are reasonable, but for 6+ and 8+ levels the calculated results differ from the observed ones by large factors. (auth)

23073 HINDRANCE PHENOMENA IN ALLOWED BETA TRANSITIONS FROM MEDIUM ODD NUCLEI. Mitsuo Sakai (Tokyo Univ.). Nuclear Phys., 33: 96-101(May 1962). (In English)

The comparative life times of allowed beta transitions from 1+, 2+, and 3+ parent nuclei are surveyed. Decay components to the ground 0+, to the first 2+ and to the second 2+ level are successively hindered. The differences of log ft values between the first and ground and the second and first beta components averaged over 23 and 14 data are 0.58 and 0.48, respectively. These retardation phenomena may correlate closely to the excitation mechanism of these states. (auth)

23074 THE $T(p,\gamma)He^4$ REACTION. D. S. Gemmell and G. A. Jones (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nuclear Phys., 33: 102-9(May 1962). (In English)

Yield curves were measured at 45, 90, and 135° for the reaction $T(p,\gamma)He^4$ at 4 to 11 Mev. No evidence was found for fine structure observed in the inverse reaction $He^4(\gamma,p)T$. Angular distributions were also measured. Results show that the gamma radiation is principally E1 but with a small E2 component which increases with excitation energy in He^4. No evidence was found for interaction in triplet states. (auth)

23075 THE (2I + 1) RULE AND THE STATISTICAL COMPOUND NUCLEUS THEORY. N. MacDonald (Atomic Weapons Research Establishment, Aldermaston, Eng.). Nuclear Phys., 33: 110-17(May 1962). (In English)

In the context of the statistical compound nucleus theory, the result that in the reaction $Al^{27}(d,\alpha)Mg^{25}$ the cross sections, integrated over angles ≥ 90°, for particular α-particle groups are described by $\sigma(I) \propto (2I + 1)$, where I is the spin of the state in Mg^{25} corresponding to the group, is discussed. The ratios of these cross sections depend on the value of the spin cut-off parameter of nuclear level density theory, which enters in calculating the effect of competing decay modes of the compound nucleus. Cross sections proportional to (2I + 1) are found in the range of I values investigated experimentally. Limitations to the usefulness of the (2I + 1) rule in the determination of spins are discussed. (auth)

23076 CIRCULAR POLARIZATION OF GAMMA RAYS IN Sc^{46}. F. Boehm and John Rogers (California Inst. of Tech., Pasadena). Nuclear Phys., 33: 118-23(May 1962). (In English)

An experimental redetermination of the degree of gamma circular polarization following the Sc^{46} beta decay confirms the existence of a large interference between Fermi and Gamow-Teller interactions yielding a matrix element ratio $M_F/M_{GT} \cong 0.22$. An investigation of chemical compounds of scandium reveals the existence of a strong attenuation of the circular polarization correlation in certain chemical states. (auth)

23077 A STUDY OF RADIATIONS FROM W^{187}. K. Maack Bisgård, K. Olesen, and P. Oestergård (Univ. of Aarhus, Denmark). Nuclear Phys., 33: 126-48(May 1962). (In English)

The decay of 24-hr W^{187} was studied using a six-gap beta spectrometer, a single-gap beta spectrometer, scintillation spectrometers, electron-gamma, and gamma-gamma coincidence techniques. Beta transitions having end-point energies of 1329 ± 5 (18), 625 ± 10 (74), and 325 ± 20 kev (8%) are found. The high-energy group corresponds to a first-forbidden transition, the second one to an allowed or first-forbidden transition. Unreported lines belonging to known transitions are measured. Intensities are given for 3 Auger electron groups and for 45 internal conversion electron groups assigned to 15 radiative transitions including a 36-kev transition not previously established. Multipole orders are found according to conversion ratios and absolute conversion coefficients. The $L_I : L_{II} : L_{III}$ conversion electron ratios for the 72-kev delayed E1 transition are normal. (auth)

23078 PAIRINGS IN THE SHELL MODEL (IV). M. Umezawa (Institut de Recherches Nucléaires, Strasbourg). Nuclear Phys., 33: 149-64(May 1962). (In English)

Casimir operators in U_Ω, SU_Ω, and Sp_Ω are given. It is shown that the pairing forces for a specific case of the intermediate pairing scheme, as well as those for the L-S and the j-j pairing schemes, can be expressed by simple linear combinations of the Casimir operators in the SU_Ω and Sp_Ω groups. For the general case in the intermediate pairing scheme, three kinds of force are introduced. The pairing energies due to these three forces can be calculated in principle for the ground states of nuclei. Special cases of the intermediate pairing scheme are presented. The eigenfunction of the ground state and its pairing energy can be approximately derived in the same way as in the L-S and the j-j limits and in the normal case of the intermediate pairing scheme, if the number of nucleons n is small in comparison with Ω, the dimension of the group. These cases include the L-S and the j-j limits and the normal case of the intermediate pairing scheme as their limiting cases. (auth)

23079 CUMULATIVE YIELDS OF THE HEAVY FRAGMENTS IN U^{235} THERMAL NEUTRON FISSION. H. Farrar and R. H. Tomlinson (McMaster Univ., Hamilton, Can.). Nuclear Phys., 34: 367-81(June 1962). (In English)

Isotopic abundances of Ba, Ce, Nd, Sm, and Cu formed in the thermal neutron fission of U^{235} were studied using a mass spectrometer. Suitable analyses of very young and old fission products made possible the normalization of the isotopic abundances of each of these elements through isobaric nucleides. The relative cumulative fission yield of every fission chain from mass 137 to 154 was obtained. These yields with relative yields of masses 131 to 137, when normalized to total 100%, give the absolute cumulative yield of all significant heavy-fragment chains. (auth)

23080 ANGULAR DISTRIBUTIONS OF THE PROTONS FROM THE $Mg^{24}(d,p)Mg^{25}$ REACTION MEASURED WITH A MULTI-CHANNEL MAGNETIC SPECTROGRAPH. R. Middleton and S. Hinds (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Nuclear Phys., 34: 404-23(June 1962). (In English)

The $Mg^{24}(d,p)Mg^{25}$ reaction was studied at 10 Mev using a 24-channel magnetic spectrograph. Angular distributions of the elastically-scattered deuterons and 44 proton groups were measured; each extended over the angular range 5 to 175°. None of the proton groups exhibits backward maxima, although 17 have strong forward maxima. These were analyzed in terms of stripping theory and l-value assignments were made in most cases. Relative reduced widths were determined using Butler theory, and these are compared with values obtained from distorted wave Born approximation theory. The consistency of the data with the predictions of the collective model is discussed. (auth)

23081 μ^--MESIC ATOMIC PROCESSES IN GASEOUS HYDROGEN. V. P. Džhelepov, S. S. Gershtein, E. A. Kushnirenko, V. I. Moskalev, and P. F. Yermolov (Joint Inst. for Nuclear Research, Dubna, USSR). Nuclear Phys., 34: 424-38(June 1962). (In English)

Using a diffusion cloud chamber in a magnetic field, μ^- atomic and molecular process are studied experimentally in hydrogen. The following quantitative data are obtained: the cross section for the elastic scattering of pμ-mesic atoms on protons, $\sigma_{pp} = (1.7^{+0.4}_{-0.5}) \times 10^{-19}$ cm^2; the rates of transfer of a μ from the proton to deuterons and complex nuclei (C and O), reduced to the density of liquid hydrogen, $\lambda_d = (0.95^{+0.34}_{-0.21}) \times 10^{10}$ sec^{-1} and $\lambda_Z = (1.2^{+0.8}_{-0.5}) \times 10^{10}$ sec^{-1}; and the rate of formation of mesic molecular ions ppμ in liquid hydrogen, $\lambda_{pp\mu} = (0.6^{+0.6}_{-0.3}) \times 10^6$ sec^{-1}. The experimental values λ_d, $\lambda_{pp\mu}$ and λ_Z agree satisfactorily with theoretical predictions, which confirms the validity of the mechanisms proposed in the theory. The cross section σ_{pp} proved to be close to the theoretical value calculated without taking into account the hyperfine structure of the mesic atom pμ. The possibility is not excluded, however, of a rapid transition to a lower state with total mesic atom spin F = 0. The determination of the absolute value of $\lambda_{pp\mu}$ makes it possible to obtain the absorption probabilities of μ-mesomolecular processes. (auth)

23082 PHOTOFISSION CROSS SECTIONS OF SEVERAL NUCLEI WITH MONO-ENERGETIC GAMMA RAYS. J. R. Huizenga, K. M. Clarke, J. E. Gindler, and R. Vandebosch (Argonne National Lab., Ill.). Nuclear Phys., 34: 439-56 (June 1962). (In English)

Gamma rays at 6.14, 6.91, and 7.12 Mev produced by the $F^{19}(p,\alpha\gamma)O^{16}$ reaction were used to induce heavy element fission. The photofission cross sections of Th^{232}, U^{238}, U^{236}, U^{235}, U^{234}, U^{233}, and Np^{237} for a 7.0-Mev average gamma energy (a mixture of the 6.91- and 7.12-Mev gamma rays) are 9, 15, 28, 33, 52, 44, and 45 mb, respectively. The cross section for producing Mo^{99} from U^{238} using 7.0-Mev gamma rays is 1.1 mb. The 7.0-Mev photon absorption cross section of heavy nuclei is 60 ± 20 mb; the gamma strength function $\bar{\Gamma}_\gamma/D$ for heavy nuclei at 7.0-Mev is $(2.5 \pm 0.8) \times 10^{-4}$. The variation in the photofission cross sections with 6.14-Mev photons for nuclei in which photoneutron emission is energetically forbidden is interpreted in terms of resonance absorption. This results from the line width of the 6.14-Mev photons (O^{16} recoils stopped prior to the emission of the 6.14-Mev γ ray) being of the same order as the average spacing between levels of the same spin in the compound nucleus. (auth)

23083 PHOTOEXCITATION OF THE ISOMERIC STATES OF Cd^{111} AND In^{115} WITH MONO-ENERGETIC GAMMA RAYS. J. R. Huizenga and R. Vandenbosch (Argonne National Lab., Ill.). Nuclear Phys., 34: 457-60(June 1962). (In English)

The cross sections for photoexcitation of Cd^{111m} and In^{115m} using gamma rays from the $F^{19}(p,\alpha\gamma)O^{16}$ reaction were measured. For a gamma beam in which the intensity ratio $(I_{6.91} + I_{7.11})/I_{6.14} = 6.7$, the $Cd^{111}(\gamma,\gamma')Cd^{111m}$ and $In^{115}(\gamma,\gamma')In^{115m}$ cross sections are 0.4 and 1.6 mb, respectively. (auth)

23084 LIFETIME MEASUREMENTS OF THE FIRST EXCITED STATES IN Os^{186} AND Os^{188}. E. Bashandy and M. S. El-Nesr (Univ. of Uppsala). Nuclear Phys., 34: 483-90(June 1962). (In English)

The lifetimes of the first excited states in Os^{186} and Os^{188} were measured by a centroid shift technique. An electron-electron coincidence spectrometer was used for energy resolution. The halflives are $T_{1/2}(Os^{186}$, 137-kev level) = $(8.7 \pm 0.4) \times 10^{-10}$ sec, $T_{1/2}(Os^{188}$, 155-kev level) = $(7.3 \pm 0.6) \times 10^{-10}$ sec. The transition probabilities were calculated and compared with those estimated from the single-particle model, and enhancement factors of 78 ± 4 and 62 ± 5 for the 137 and 155-kev transitions were obtained. The data on Os^{188} are compared with theory. (auth)

23085 ON INDUCED PSEUDOSCALAR INTERACTION IN β-DECAY. L. D. Blokhintsev and E. I. Dolinskii (Moscow State Univ.). Nuclear Phys., 34: 498-9(June 1962). (In English)

The appearance of weak interaction form factors in external electromagnetic fields is discussed. (auth)

23086 BETA DECAY ASYMMETRY OF Li^8, Ag^{108} AND Ag^{110} NUCLEI PRODUCED IN THE CAPTURE OF POLARIZED THERMAL NEUTRONS. Y. G. Abov, O. N. Yermakov, A. D. Gulko, P. A. Krupchitskii, and S. S. Trostin (Inst. of Theoretical and Experimental Physics, Moscow). Nuclear Phys., 34: 505-9(June 1962). (In English)

A study is made of the beta decay asymmetry of Li^8, Ag^{108}, and Ag^{110} nuclei produced in the capture of polarized thermal neutrons. The capture of thermal neutrons by Li^7 nuclei occurs mostly in the production of a spin 2^- compound nucleus. The spin 1^- compound states of Ag^{108} and Ag^{110} are notable in the capture of thermal neutrons by Ag^{107} and Ag^{109} nuclei. An estimate is made of the relaxation time of Ag^{108} nuclear moments in AgCl at 6°K. (auth)

23087 COLLECTIVE PROPERTIES OF THE NUCLEAR ANISOTROPIC HARMONIC OSCILLATOR MODEL. B. J. Verhaar (Universiteit, Amsterdam). Nuclear Phys., 35: 1-26(June 1962). (In English)

To study the nature of collective motions in deformed potential well models, the translation and, especially, the rotation of the nucleons is considered in a simple version of such a model. In this version the well is taken to have

an anisotropic harmonic oscillator shape. The simplicity of the model has the advantage of allowing for more explicit considerations. The treatment of collective translations is analogous to that for the isotropic oscillator well. For the case of collective rotations, a set of eigenfunctions is shown to exist, which are approximately separable into a collective rotational factor and a factor containing only variables of other degrees of freedom. (auth)

23088 MUON CAPTURE IN THE SHELL MODEL. Ian Duck (California Inst. of Tech., Pasadena). Nuclear Phys., 35: 27-48 (June 1962). (In English)

The Primakoff Hamiltonian is used in conjunction with the nuclear shell model to predict muon capture rates to the bound states of N^{16}, O^{19}, and H^3. Values obtained are: for N^{16}, $\Gamma = 20 \times 10^3$ sec^{-1}; for O^{19}, $\Gamma = 1350$ sec^{-1}; and for H^3, $\Gamma = 1250$ sec^{-1}. (auth)

23089 OPTICAL MODEL WITH POLYNOMIAL POTENTIAL. A. V. Luktanov, Yu. V. Orlov, and V. V. Turovtsev (Moscow State Univ.). Nuclear Phys., 35: 71-84 (June 1962). (In English)

The form of the potential of the optical model with surface absorption is investigated. Parameters making it possible to describe accurately the experimental data on the scattering of 14-Mev neutrons are selected for the potential in the form of polynomials. Different potentials are compared. (auth)

23090 NUCLEON REDUCED WIDTHS AND CHARGE INDEPENDENCE. Albert Altman, William M. MacDonald, and Jerry B. Marion (Univ. of Maryland, College Park). Nuclear Phys., 35: 85-94 (June 1962). (In English)

A criterion (called the isobaric spin addition rule) is established for the comparison of nucleon reduced widths of $T = 1$ levels in isobaric triads. The rule is shown to be essentially independent of any isobaric spin impurity in the $M_T = 0$ level. This criterion is used in an analysis of the mirror levels at 8.89 Mev in B^{10} and 7.37 Mev in Be^{10}. If the spin and parity assignment of the mirror levels is changed from its accepted value of 3^+ to 3^-, now indicating d-wave formation, the rule is satisfied within experimental error. This different parity assignment for these mirror levels is not excluded by the $Be^9(n,n)Be^9$ angular distribution measurements and is in agreement with the results of high-energy stripping data. If p-wave formation of the levels is assumed it is found that the isobaric spin addition rule is not satisfied. (auth)

23091 ENERGY LEVELS OF Cl^{34} WITH REALISTIC POTENTIALS. V. L. Narasimham (Muslim Univ., Aligarh, India). Nuclear Phys., 35: 95-7 (June 1962). (In English)

The energy levels of Cl^{34} calculated in the Born approximation by using a separable 2-body ($T = 0$) potential, are recalculated with the help of the exact reaction matrix for nucleons in the presence of nuclear matter. It is found that the results largely reduce the discrepancy between theory and experiment by enhancing the (attractive) triplet s-state contribution, and by reducing the (repulsive) singlet p-state contribution. Non-cental effects on the energy levels appear to be negligible. (auth)

23092 TWO-QUANTUM TRANSITIONS OF ATOMIC NUCLEI. D. P. Grechukhin (Kurchatov Atomic Energy Inst., Moscow). Nuclear Phys., 35: 98-113 (June 1962). (In English)

Simultaneous radiation of two quanta of multipolarities L_1 and L_2 in nuclear transitions are considered. Formulae are obtained for the angular correlations, the shape of the quantum spectrum, and the total probability of two-quantum nuclear transitions. It is shown that the shape of the spectrum does not depend on the parity of the quanta and is determined only by the multipolarities of the quanta radiated when there are no levels close to the initial level of the nucleus. If there are such levels the shape of the nuclear spectrum depends on the matrix elements of the nuclear radiation operators L_1 and L_2. (auth)

23093 THE EFFECT OF SPIN-DEPENDENT FORCES ON COLLECTIVE MOTION IN NUCLEI. Leonard S. Kisslinger (Western Reserve Univ., Cleveland). Nuclear Phys., 35: 114-35 (June 1962). (In English)

The vibrational state in even-mass, single-closed-shell nuclei is studied using a pairing force plus the part of the tensor force that can give rise to a 2^+ collective state in the approximation of a dilute quasi-particle system. From the empirical energies of vibrational states the strength of this spin-dependent force is estimated, from which the B(E2) values as well as the energy levels of the odd-mass nuclei are calculated. The results of this calculation are compared to the results of calculations using a pairing force plus a quadrupole force, and to experimental results. The conclusion is drawn that the spin-quadrupole force cannot be the dominant component of the residual interaction leading to the vibrational states, but that a choice of the strength parameter of about 20% of the ordinary quadrupole force is not ruled out, and might improve the systematic calculations. (auth)

23094 FOUR AND MORE NUCLEONS OUTSIDE CLOSED SHELLS. Po^{212} SPECTRUM. I. M. Band, Yu. I. Kharitonov, and L. A. Sliv (Leningrad Inst. of Physics and Tech.). Nuclear Phys., 35: 136-51 (June 1962). (In English)

The spectrum of excited states and transitions between them are calculated for a nucleus with two nucleon pairs in excess of the closed shells. The residual pair interaction is taken into account, apart from the self-consistent potential. The importance of the interaction in such a nucleus is shown. The spectrum of eight nucleons is discussed on the basis of the results obtained. (auth)

23095 THE DECAY OF Eu^{147} TO LEVELS IN Sm^{147}. C. F. Schwerdtfeger, H. J. Prask, and J. W. Mihelich (Univ. of Notre Dame, Ind.). Nuclear Phys., 35: 168-76 (June 1962). (In English)

The electron capture of Eu^{147} is investigated with magnetic and scintillation spectrometers, and with coincidence and gamma-gamma directional correlation techniques. Eu^{147} decays with a 23.6 ± 1.0 day half life to levels in Sm^{147} at 122, 198, 800, and 1079 kev. A decay scheme is proposed. (auth)

23096 THE EVAPORATION OF NEUTRONS FROM NUCLEI BOMBARDED WITH HIGH ENERGY PROTONS. D. M. Skyrme (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nuclear Phys., 35: 177-93 (June 1962). (In English)

Cross sections for neutron evaporation were measured by bombarding targets of tungsten, copper, and aluminum with protons. Measurements were made on these elements at 180° to the direction of motion of the incident protons, and were extended in the case of tungsten to cover the angular range 52.5 to 177.5°. Neutron fluxes were measured with photographic plates and counters. The energy distribution of the neutrons was investigated and the average number of neutrons emitted by an excited nucleus was calculated. The shape of the energy spectra and the values obtained for the average number of evaporated neutrons were discussed in terms of the evaporation theory of nuclear disintegrations. Nuclear temperatures were estimated from the mean kinetic energy of the emitted neutrons, and hence values were obtained for the initial nuclear excitation

energy. These values agree fairly well with independent estimates. The angular distribution of the neutrons and detailed shapes of the energy spectra are not in complete agreement with those expected to result from a pure evaporation process. (auth)

23097 THE SCATTERING OF HIGH ENERGY NEUTRONS FROM Li^6. Daphne F. Jackson (Battersea Coll. of Tech., London). Nuclear Phys., 35: 194-208(June 1962). (In English)

The inelastic scattering of neutrons exciting the 2.18-Mev level of Li^6 is investigated in the impulse approximation. The differential cross section and the polarization are calculated for incident energies of 40, 90, and 156 Mev. Distortion of the wave function for the scattered nucleon is taken into account using a W.K.B. approximation with a spin-independent optical model potential, and the effect of variation of the optical model parameters is examined. The center-of-mass correction usually applied to the Born approximation is extended to the distorted wave approximation. The differential cross section and the polarization for elastic scattering are calculated in Born approximation at 156 Mev. (auth)

23098 ON COLLECTIVE LEVELS OF NON-SPHERICAL NUCLEI. M. G. Urin and D. F. Zaretsky (Moscow Engineering-Physical Inst. and Kurchatov Atomic Energy Inst., Moscow). Nuclear Phys., 35: 219-31(June 1962). (In English)

The β- and γ-vibrational levels in non-spherical nuclei are interpreted microscopically. Using the method of approximate second quantization an equation is obtained for determining excitation energies of these levels. Electromagnetic transition probabilities are also calculated for the levels. The theory is compared with experimental data. (auth)

23099 ALPHA SPECTROSCOPY OF Ra^{223}(AcX) AND ITS DAUGHTERS. R. J. Walen, V. Nedovessov, and G. Bastin-Scoffier (CNRS. Orsay, France). Nuclear Phys., 35: 232-52(June 1962). (In French)

Low-background α spectroscopy of Ra^{223} and its daughter products shows levels in Rn^{219}, Po^{215}, Pb^{211} and Tl^{207}. This (second excited) state of Tl is not $h^{11}/_2$. The levels of Rn^{219} and Po^{215} are difficult to fit reasonably with the collective model in the absence of information on spins for all the levels excited with low intensity. (auth)

23100 EVAPORATION NEUTRON SPECTRA. V. A. Sidorov (Kurchatov Atomic Energy Inst., Moscow). Nuclear Phys., 35: 253-9(June 1962). (In English)

The neutron spectra produced in the bombardment of V, Co, and Ni targets by α particles at 11 to 20 Mev are measured using the time-of-flight method. The analysis of these spectra according to the statistical theory of nuclear reactions is performed with an electronic computer. The level density function type that gives optimal agreement with experiment is determined. The deviations of the observed shape of the spectrum from the calculated one, leading to the apparent dependence of the residual nucleus temperature on the incident α-particle energy, should be attributed to the emission of neutrons during the establishment of the thermal equilibrium of the compound nucleus. (auth)

23101 STUDY OF Ce^{144} DECAY SCHEME BY COINCIDENCE METHOD. N. V. Forafontov, V. S. Shpinel, and Ts. Vasilev (Moscow State Univ.). Nuclear Phys., 35: 260-72(June 1962). (In English)

The Ce^{144} decay is studied by means of a two-lens β spectrometer and a luminescent $\beta(\gamma)$ spectrometer. A decay scheme containing a level at 147 kev is constructed on the basis of β-e^-, e^--e^- and γ-e^- coincidence measurements. (auth)

23102 THE PENETRATION EFFECT IN ELECTRIC DIPOLE INTERNAL CONVERSION. Gustav Kramer and Sven Goesta Nilsson (Univ. of California, Berkeley). Nuclear Phys., 35: 273-94(June 1962). (UCRL-9877). (In English)

Nuclear-structure-dependent contributions to the internal conversion process are considered in conjunction with highly retarded electric dipole transitions. Formulas for a theory of anomalous internal conversion for electric transitions are given. These formulas are applied to explain the strong E1 anomalies found for L conversion. Two different types of anomalous matrix elements occur—one associated with the nuclear charge, the other with the nuclear current. It is found that the contribution associated with charge is negligible. In the current terms two parts are also found, the convection current and spin current, which are associated with different selection rules and which generally are both important. From the empirical data of the L_I and L_{II} anomaly the sign of the ratio of nuclear matrix elements that gives the dominant contribution to the anomalous conversion amplitude is deduced. The anomalous nuclear matrix elements are evaluated for the single-particle model. Effects of pair correlation are discussed. Agreement is found with experiments. (auth)

23103 TRENDS IN NUCLEAR REACTION CROSS SECTIONS. II. THE EFFECT OF PAIRING ENERGY δ VALUES. Donald G. Gardner (Illinois Inst. of Tech., Chicago) and A. D. Poularikas. Nuclear Phys., 35: 303-10 (June 1962). (In English)

Three different sets of nuclear pairing energies (δ) are used to predict the (n,p) cross sections at 14.5 Mev of the isotopes of iron, copper, and zinc. It is shown that the two values δ_Z = 1.7 and δ_N = 2.5 Mev yield more accurate predictions than the other two sets (wherein δ_Z and δ_N are assigned a different value for each Z and N). The isotopes of cadmium illustrate that the inclusion of Q values and δ values improves the systematics of (n,p) reactions. (auth)

23104 CONCERNING RESONANCE SCATTERING OF GAMMA RAYS AND LEVEL WIDTHS IN Hf^{177}. U. Hauser (California Inst. of Tech., Pasadena). Nuclear Phys., 35: 342-7(June 1962). (In English)

Lifetimes of excited states in Hf^{177} obtained by Hamilton and Sood (Nuclear Phys., 27: 66(1961)), by nuclear resonance scattering, disagree considerably with those obtained by other methods. It is shown that their formula for the ratio of the nuclear resonance to the Rayleigh cross section must be modified, and the correct expressions are given. In consequence of this finding, it is found that the 250-kev level is resonantly excited and not the 321-kev level as reported. (auth)

23105 THEORY OF RESONANCE ABSORPTION OF NEUTRONS. Rubin Goldstein and E. Richard Cohen (Atomics International, Canoga Park, Calif.). Nuclear Sci. and Eng., 13: 132-40(June 1962).

A treatment of resonance absorption intermediate between the narrow (NR) and wide resonance (WR) approximations is developed for homogeneous systems. An arbitrary parameter, λ, is introduced into the flux and two distinct approximations are employed to determine λ as a function of the resonance parameters. One approximation is based upon a method of equating successive orders of approximation and the other is based upon a variational principle. Formulas are given, from which the resonance integral may be calculated. The parameter λ character-

ines, in essence, the location between the NR and WR extremes, of the actual resonance. When λ is set equal to 0 or 1, the first-order WR or NR integrals are obtained. Sample calculations are carried out for an intermediate case (the 192-ev resonance of U^{238} in a 1:1 atomic mixture with hydrogen) using linear and nonlinear trial functions for both types of approximations. All results agree to within less than one per cent of 0.172 barns. In comparison, the usual extreme energy-loss assumptions yield results which differ by more than a factor of 2 (0.121 and 0.253 barns for the NR and WR approximations, respectively. (auth)

23106 MEASUREMENT OF ISOTOPIC SHIFTS OF THE RESONANCE LINE OF BARIUM. A. N. Razumovskii and M. P. Chaĭka. Optics and Spectroscopy (U.S.S.R.) (English Translation), 12: 186-9(Mar. 1962).

The isotopic shift of BaI 5535.6 Å ($6s^2\ S_0^1 - 6s6p\ P_1^1$) was measured, using highly-enriched, separated isotopes. The shifts, expressed in 10^{-2} cm^{-1}, were: O(Ba^{138}), 5.7(Ba^{137}), 4.2(Ba^{136}), 7.6(Ba^{135}), and 4.7(Ba^{134}). The main difficulty is the determination of the position of a spectral line with a high degree of accuracy. Attention was concentrated on obtaining this accuracy and on evaluating errors. (auth)

23107 TRANSMISSION OF POLARIZED NEUTRONS THROUGH SAMPLES OF POLARIZED Ho^{165} NUCLEI. Hans Postma, H. Marshak, V. L. Sailor, F. J. Shore, and C. A. Reynolds (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 126: 979-85(May 1, 1962). (BNL-5857)

Transmission experiments were carried out using polarized-monochromatic neutrons, polarized Ho^{165} nuclei and polycrystalline samples of holmium-ethyl sulfate and holmium metal. The spins of the two excited states of the compound nucleus corresponding to the neutron resonances at 3.92 and 12.8 ev are assigned as $J = I + \frac{1}{2} = 4$. The nuclear polarization obtained for the metal sample has the same sign and magnitude as in the holmium-ethyl sulfate. The hyperfine constant A/k was calculated to be 0.61 ± 0.06°K for the ethyl sulfate and 0.65 ± 0.08°K for the metal. The depolarization of the neutron beam in passing through the magnetized samples was studied at thermal energies. (auth)

23108 HYPERFINE STRUCTURE OF PRASEODYMIUM-142. Amado Y. Cabezas, Ingvar P. K. Lindgren, Richard Marrus, and William A. Nierenberg (Univ. of California, Berkeley). Phys. Rev., 126: 1004-8(May 1, 1962). (UCRL-9891)

The hyperfine structure of 19-hr Pr^{142} in the electronic ground state $^4I_{9/2}$ was studied by the atomic-beam magnetic-resonance method. The following were obtained: electronic splitting factor $g_J(^4I_{9/2}) = -0.7322$ (3), nuclear spin I = 2, magnetic-dipole hyperfine-structure constant |A| = 67.5(5) Mc/sec, electric-quadrupole hyperfine-structure constant |B| = 7.0(2.0) Mc/sec, and B/A > 0. From the hyperfine-structure constants and assumptions made concerning the electronic fields at the nucleus, the nuclear moments are $|\mu_I| = 0.297(15)$ nm and |Q| = 0.035(15) b, with $Q/\mu_I > 0$. (auth)

23109 ELASTIC SCATTERING AT RESONANCE FROM BOUND NUCLEI. G. T. Trammell (Oak Ridge National Lab., Tenn.). Phys. Rev., 126: 1045-54(May 1, 1962).

The usual Debye-Waller factor, $\langle \exp[-i(k_f - k_0)\cdot r]\rangle$, which when multiplying the fixed-scatterer amplitude gives the nonresonant elastic-scattering amplitude from a bound scatterer, is generally applicable only for fast collisions, i.e., if the "collision time," $\hbar(d/dE)$ (scattering phase shift), is much less than a characteristic vibration time, ω_m^{-1}, of the bound scatterer about its mean position. In the opposite extreme case, where the "collision time" is very long compared to ω_m^{-1} (slow collisions), there is negligible correlation between the positions of absorption and subsequence re-emission (for an atom bound in a crystal), and the "Debye-Waller" factor becomes $\langle \exp(-ik_f\cdot r)\rangle\langle \exp(ik_0\cdot r)\rangle$. If the scatterers' surroundings exhibit cubic symmetry, the extremes as well as all intermediate cases give the same factor for 90° scattering angle. For medium collisions, collision time ≈ vibration time, the elastic scattering amplitude becomes sensitive to the detailed vibrational spectrum of the bound scatterer. For nonresonant scattering, the collision times are of the order of transit times (x ray across the atom for Thomson scattering, neutron across the nucleus for neutron potential scattering) and are thus fast collisions. The inverse characteristic vibration times of atoms in crystals are of the order of their Debye Θ and are a few hundredths of an ev. Slow neutron nuclear resonance widths vary from a few hundredths to a few tenths ev; therefore slow neutron collisions are medium to fast. Gamma resonances for $E_\gamma < 100$ kev (Mössbauer) have widths less than 10^{-6} ev and correspond to slow collisions. A slight generalization of a formula due to Lamb gives the resonant scattering, and discussion of the formula is largely a straightforward extension of those of Lamb and Singwi and Sjoelander in discussions of resonance absorption. The total absorption scattering cross section may be obtained from the elastic scattering amplitude. (auth)

23110 STRIPPING WITH 28-Mev DEUTERONS. R. J. Slobodrian (Comisión Nacional de Energía Atómica, Buenos Aires). Phys. Rev., 126: 1059-64(May 1, 1962).

A study of (d,t) and (d,p) reactions was performed using 28-Mev deuterons. The outgoing particles were analyzed using a scintillation spectrometer. The absolute differential cross section of the following processes was measured: $Li^7(d,t)Li^6$, $Be^9(d,p)Be^{10}$, $Be^9(d,p)Be^{10*}$ −3.37 Mev, $B^{10}(d,p)B^{11}$, $C^{12}(d,p)C^{13}$, and $C^{12}(d,p)C^{13*}$ −3.68 Mev. Angular distributions were fitted by direct-interaction plane-wave theoretical curves. All the reactions take place between states of known spin and parity. The $Li^7(d,t)Li^6$ reaction can be fitted using a "pickup" curve corresponding to l = 1 and a = 5 f, where l is the angular momentum change and a is the interaction radius. With the exception of the reaction $C^{12}(d,p)C^{13*}$ −3.68 Mev, the stripping angular distributions exhibit a secondary oscillation from a second value of l contributing to the cross section. The angular distributions of the following processes were fitted by superimposing the theoretical curves of l = 1 and l = 3, $Be^9(d,p)Be^{10}$ with an interaction radius a = 3.5 f, $Be^9(d,p)Be^{10*}$ −3.37 Mev with a = 3.8 f, $B^{10}(d,p)B^{11}$ with a = 3.6 f, and $C^{12}(d,p)C^{13}$ with a = 3.5 f. The $C^{12}(d,p)C^{13*}$ −3.68 Mev angular distribution was fitted using a theoretical curve of l = 1 and a = 3.4 f. The stripping reduced widths were calculated for the l contributions to the experimental cross section. The appearance of the f component in addition to the p component predicted by the shell model in the differential cross sections, tentatively assumed, could be due to configuration mixing, and the levels connected by the transitions should not be pure shell-model states. (auth)

23111 ELLIPTICAL POLARIZATION OF Fe^{57} GAMMA RAYS. H. Frauenfelder, D. E. Nagle, R. D. Taylor, D. R. F. Cochran, and W. M. Visscher (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 126: 1065-75(May 1, 1962).

The Mössbauer effect provides a tool to investigate the angular dependence and the polarization of individual com-

ponents emitted in the nuclear Zeeman effect. A discussion of the physical picture of the photon polarization in Fe^{57} is followed by the general theory of elliptical polarization in the Mössbauer effect. The experimental arrangement to measure this polarization is described, and relevant results are given. (auth)

23112 DISTORTION EFFECTS IN THE $Ca^{40}(d,p)Ca^{41}$ REACTION. W. Tobocman and W. R. Gibbs (Rice Univ., Houston, Tex.). Phys. Rev., 126: 1076-81(May 1, 1962).

A series of calculations was carried out in which the optical-model parameters were varied in the distorted-wave Born approximation. The theoretical (d,p) cross section was obtained as a function of V, W, R, and a for the $Ca^{40}(d,p)Ca^{41}$ reaction. Preliminary comments on the stripping from the interior of the nucleus are also made. An attempt is made to obtain best fits to the (d,p) angular distributions from four levels of Ca^{41} at 4.31- and 4.69-Mev incident energy. (auth)

23113 EVAPORATION OF COINCIDENT PROTONS IN $\alpha + Ni^{58}$ REACTIONS. D. Bodansky, R. K. Cole, W. G. Cross, C. R. Gruhn, and I. Halpern (Univ. of Washington, Seattle). Phys. Rev., 126: 1082-96(May 1, 1962).

A study was made of nuclear reactions in which two or more protons are emitted, in the bombardment of nickel isotopes by alpha particles. The most extensive data were obtained for 32-Mev alpha particles, using a Ni^{58} target. A smaller amount of data were obtained at 27 and 42 Mev, and using Ni^{60} and Ni^{62} targets. The two protons were observed in a coincidence arrangement, using scintillation counter $dE/dx - E$ detectors. The energy correlations and distributions, the angular correlations and distributions, and the yields were compared with predictions based on the statistical theory. There was extensive agreement; most of the observed events arise from evaporation from an excited compound nucleus. For Ni^{58} at 32 Mev, the cross section for compound nuclear events in which two or more protons are evaporated was 560 ± 50 mb which is over one-third the total reaction cross section. This large cross section can be quantitatively understood in terms of the proton richness of the emitting compound nucleus. This follows from an analysis in which it is shown that the relative proton and neutron emission probabilities (especially using 14-Mev incident neutrons) are correlated with proton richness. (auth)

23114 SENIORITY OF THE $f_{5/2}^4$ LEVELS IN Cr^{52}. I. Talmi (Princeton Univ., N. J.). Phys. Rev., 126: 1096-8(May 1, 1962).

The seniorities of recently observed levels in Cr^{52} are considered. The energies as well as M1 transition rates agree with a $f_{5/2}^4$ assignment. There is not enough experimental information about the possible operation of the E2 selection rule ($\Delta\nu = 2$ but no $\Delta\nu = 0$) for this configuration. (auth)

23115 DELAYED NEUTRON YIELDS IN THE PHOTOFISSION OF U^{238} AND Th^{232}. G. Moscati and J. Goldemberg (Universidade de São Paulo, Brazil). Phys. Rev., 126: 1098-9(May 1, 1962).

The delayed neutron yield per fission in the photofission of U^{238} and Th^{232} was measured using a 22-Mev betatron. The results are 0.036 and 0.030, respectively; empirical predictions are substantiated. No evidence of a dependence of this ratio as a function of energy was found. (auth)

23116 INDUCED PSEUDOSCALAR INTERACTION AND THE LOW-ENERGY ANOMALIES IN BETA SPECTRA. J. M. Pearson (Universite de Montreal, Can.). Phys. Rev., 126: 1100-4(May 1, 1962).

An unsuccessful attempt is made to interpret in terms of the induced pseudoscalar interaction the $(1 + a/W)$ anomaly factors found by Langer, et al., in the shapes of the allowed Gamow-Teller beta spectra. The observation that the Hamiltonian of the induced pseudoscalar interaction in nuclear beta decay differs from that of the "basic" pseudoscalar interaction is taken into account. The shape factors for the transitions in question are derived to display an anomaly of the required form. In the case of pure Gamow-Teller transitions, arbitrarily large distortions are possible provided that an appropriate destructive interference takes place between the axial vector and induced pseudoscalar terms. For a mixed Fermi-Gamow-Teller transition there is a definite upper limit to the amount of distortion which the induced pseudoscalar interaction can cause. This limit is greatly exceeded by the Zr^{89} spectrum; the anomaly must have some other origin. Until the reason for these anomalies is understood, it would be unsafe to draw any conclusion concerning the strength of the induced pseudoscalar interaction on the basis of low-energy spectrum shapes. (auth)

23117 POLARIZATION AND DIFFERENTIAL CROSS SECTION FOR NEUTRON SCATTERING FROM SILICON. R. O. Lane, A. J. Elwyn, and A. Langsdorf, Jr. (Argonne National Lab., Ill.). Phys. Rev., 126: 1105-11(May 1, 1962).

The polarization of neutrons scattered from Si and the unpolarized differential cross section for the process are measured at 5 angles at 0.2 to 0.7 Mev. The differential cross sections, together with previously measured cross sections, are analyzed in terms of the properties of the resonance levels seen in Si^{29} ($Si^{28} + n$) by the R-function formalism of Lane and Thomas. The levels in Si^{29} at neutron energies of 0.536 and 0.571 Mev are assigned to be $D_{\frac{5}{2}}$ and $P_{\frac{3}{2}}$, respectively. The phase shifts obtained from this analysis are used to predict the polarization in the scattering from Si^{28}. The predicted values agree well with the measured polarization in scattering from natural Si. However, the rapid variation of the polarization with energy limits the usefulness of Si as an analyzer near the resonance energies. Below 0.4 and above 0.65 Mev, the polarization is practically zero. The agreement between calculated and measured polarizations gives added confirmation of previous measurements of the polarization of the neutrons in the $Li^7(p,n)Be^7$ reaction, which was used as the neutron source. (auth)

23118 NUCLEAR ROTATIONAL SPECTRA, THE ELLIOTT MODEL, AND THE P_2 FORCE. Raymond S. Willey (Stanford Univ., Calif.). Phys. Rev., 126: 1127-38(May 1, 1962).

The essential features of the Elliott Model with the momentum-dependent quadrupole-quadrupole operator which leads to $L(L + 1)$ rotational spectra are reviewed. The operator is reduced to a momentum-independent residual interaction differing from the P_2 interaction. The model Hamiltonian is separated into a rotational Hamiltonian, a deformed "intrinsic" Hamiltonian, and a perturbation term. The eigenfunctions and eigenvalues of the "intrinsic" Hamiltonian are found and used in Inglis' cranking model formula to calculate the moment of inertia. The model is modified by taking a mixture of the long-range "P_2" interaction with the short-range δ-function force. For an intermediate mixture, the spectrum obtained resembles the spectrum predicted by the collective vibrational model. Finally, the implications of a P_2 residual interaction for direct-interaction inelastic scattering processes are considered. The question is discussed whether

the P_2 residual interaction may be observed in rotational nuclei, and, if so, whether the strength of the P_2 interaction scattering experiments is consistent with that determined from the observed rotational spectra. Within the rough approximations made, the few experimental results available are not inconsistent with the calculation. (auth)

23119 COMPARISON OF ALPHA-PARTICLE ENERGIES FROM Po^{210} AND Po^{214} AND THE ENERGY OF Po^{210} ALPHA PARTICLES. Cornelius P. Browne (Univ. of Notre Dame, Ind.). Phys. Rev., 126: 1139-42(May 1, 1962).

The energies of alpha particles emitted by Po^{210} and Po^{214} were compared using a broad-range spectrograph. Techniques were the same as those used in a comparison of the Po^{210} alpha energy with the $Li^7(p,n)Be^7$ reaction threshold energy. The result agrees with other measurements, and the discrepancy between the Po^{210} alpha energy measured against the Briggs value for Po^{214} and the Po^{210} alpha energy measured absolutely or against the $Li^7(p,n)Be^7$ threshold remains. If Rytz's absolute value for the Po^{214} energy is used, the discrepancy disappears. The alpha energy from Po^{210} is about 5.3045 Mev. (auth)

23120 NEUTRON-INDUCED DISINTEGRATION OF Li^6 AND Li^7. L. Rosen and L. Stewart (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 126: 1150-1(May 1, 1962).

The $Li^6(n,dn)He^4$ and $Li^7(n,tn)He^4$ reactions at 5 to 14 Mev are studied. The cross sections are large; normal Li may have important applications as a shielding material for fission and fusion reactors. (auth)

23121 LARGE-TIME EXPONENTIAL DECAY AND "HIDDEN VARIABLES." Rolf G. Winter (Pennsylvania State Univ., University Park). Phys. Rev., 126: 1152-3 (May 1, 1962).

If "hidden variables" exist, they might be observable in radioactive samples that have decayed for many half lives. No large deviations from exponential decrease occur in the decay of the intensity of the 1.8-Mev gamma rays from Mn^{56} during the first 34 half lives. (auth)

23122 BETA-GAMMA DIRECTIONAL CORRELATION IN Eu^{154}. S. K. Bhattacherjee and S. K. Mitra (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 126: 1154-9(May 1, 1962).

The directional correlation between the nonunique first-forbidden outer beta group of end-point energy 1855 kev in Eu^{154} and the 123-kev cascade gamma ray in Gd^{154} was measured at 12 beta energies. The measured beta-gamma correlation coefficient ϵ ranges from $-(0.222 \pm 0.013)$ to $-(0.314 \pm 0.017)$ at 1150 to 1700 kev, after correcting for the attenuation due to the extranuclear field effect by measuring the attenuation factor $G_2 = 0.71 \pm 0.03$ in the 1277-123– kev gamma-gamma cascade in Gd^{154}. The correlation coefficient ϵ varies almost as (p^2/W) in this energy interval. The attenuation effect on the beta-gamma correlation coefficient under different physical conditions of the source was demonstrated experimentally. An analysis of the data by an electronic computer leads to values of the matrix element ratios (Kotani's notation): $z = 1$, $x = 0.5 \pm 0.05$, $u = 0 \pm 0.05$, and $Y = 1.55 \pm 0.10$. The "modified B_{ij} approximation" is reasonably valid in this beta decay. (auth)

23123 GROSS STRUCTURE AND 1d-SHELL NUCLEI. W. C. Parkinson and J. R. Maxwell (Univ. of Michigan, Ann Arbor). Phys. Rev., 126: 1160-4(May 1, 1962).

High-resolution data for (1d,2s)-shell nuclei suggest that the requirements necessary for valid interpretation of gross-structure measurements are not met. Data for Mg^{27}, Al^{29}, P^{32}, and S^{33} are discussed. There is limited evidence of similar difficulties in the 1f shell. (auth)

23124 MEASUREMENT OF THE MAGNETIC MOMENT OF THE 279-kev STATE IN Tl^{203} USING RESONANCE FLUORESCENCE. B. I. Deutch (Franklin Inst., Swarthmore, Penna.). Phys. Rev., 126: 1168-72(May 1, 1962).

Using an ultracentrifuge, nuclear resonance fluorescence was observed by detecting the scattered gamma radiation from the 279-kev level in Tl^{203}. The rotation of the large anisotropic resonance-scattering pattern from this level was measured when a Tl scatterer was placed in an external field perpendicular to the plane of the scattering. The measured precession angle corresponds to a magnetic moment of the 279-kev state in Tl^{203}, $\mu_{279} = +0.35 \pm 0.26$ nm. The result agrees with two theoretical predictions of μ_{279}: the single-particle model prediction of Kisslinger and the (Hg^{202} core + odd particle) model calculation of deShalit. (auth)

23125 RECOIL BEHAVIOR OF THE $Cu^{63}(p,pn)Cu^{62}$ REACTION. E. R. Merz and A. A. Caretto, Jr. (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 126: 1173-80 (May 1, 1962).

The recoil behavior of the $Cu^{63}(p,pn)Cu^{62}$ reaction was measured at 100 to 400 Mev by performing radiochemical integral recoil experiments. The fraction of the total Cu^{62} produced, found in the forward, backward, and right angle directions, shows definite structure with increasing bombarding energy. The data can be qualitatively interpreted by assuming the two-step cascade-evaporation mechanism to be relatively more important at low incident energies and a knock-on mechanism to be relatively more important at the higher incident energies. By a postulated velocity vector diagram, the average recoil range as a function of incident energy was calculated; this was converted to Cu^{62} kinetic energy by an experimentally determined range-energy relationship. The Cu^{62} had an average kinetic energy of 380 kev at 105 Mev incident energy, decreased to 105 kev at about 200 Mev, and then increased to 195 kev at 400 Mev. This is interpreted in terms of the cascade-evaporation mechanism and the knock-on mechanism. (auth)

23126 ISOBARIC YIELDS IN THE REACTIONS OF 2.9-Bev PROTONS WITH ARSENIC-75. Sheldon Kaufman (Brookhaven National Lab., Upton, N. Y. and Princeton Univ., N. J.). Phys. Rev., 126: 1189-94(May 1, 1962). (PPAD-431-E)

Cross sections for the formation of four isobars of A = 72 from bombardment of As^{75} with 2.9-Bev protons are reported. The cross sections as a function of Z fit a Gaussian curve having a peak at Z = 32.3 and a width at half-maximum of 1.4 charge units. Cross sections for six other nuclides in the mass range $66 \leq A \leq 74$ were measured, and their cross sections lie close to the Gaussian when plotted against $Z - Z_A$, with the exception of As^{74}. An analysis of the yields of Ga^{72} and Zn^{72} indicates that most of the Zn^{72} is not formed in a (p,4p) reaction but in a ($p,3pn\pi^+$) reaction, or similar process in which one or more π^+ mesons are emitted, having a cross section of >0.018 mb. (auth)

23127 THE PHOTOPRODUCTION OF CHARGED PIONS FROM CALCIUM. E. H. Bellamy and W. R. Hogg (Univ. of Glasgow). Proc. Phys. Soc. (London), 79: 1197-1202(June 1, 1962).

Relative numbers of π^- and π^+ produced from Ca by bremsstrahlung beams (280 and 320 Mev maximum energy) were measured. Pions of 15, 28, and 48 Mev mean energy (emitted at 152° to the photon beam) were magnetically selected and counted in a coincidence arrangement. The π^-/π^+ ratio drops from about unity to 0.28 with increasing pion and decreasing photon energy. The results agree qualitatively with the surface-production model. (auth)

23128 FIRST-FORBIDDEN BETA DECAY. Hans A. Weidenmueller (California Inst. of Tech., Pasadena). Revs. Modern Phys., 33: 574-607 (Oct. 1961).

Theory on forbidden β decay is discussed; it is assumed that the interaction is purely vector and axial vector and that the neutrino two-component theory holds. Invariance under time reversal is assumed. Methods and approximations are described, and derivations of final formulas are discussed. Techniques in studying nuclear matrix elements are given. (L.N.N.)

23129 STRUCTURE OF NUCLEI AND NUCLEONS. R. Hofstadter (Stanford Univ., Calif.). Science, 136: 1013-22 (June 22, 1962).

Analyses are made using high-energy electron scattering. Two-parameter descriptions of nuclear charge density distributions were obtained; a Au nucleus approximate model is presented in graphical form. Nucleon form factors are presented and discussed. It is indicated that nucleons are highly complex bodies. (L.N.N.)

23130 (n,α) REACTIONS INITIATED BY 14-Mev NEUTRONS IN Si^{28} AND Si^{29}. G. Andersson-Lindstroem (Physikalischen Staatsinstitut, I. Institut für Experimentalphysik, Hamburg). Z. Naturforsch., 17a: 238-41 (Mar. 1962). (In German)

A Si semiconductor counter was irradiated with neutrons at energies of 14.1, 14.4, and 14.6 Mev and the α spectrum from $Si^{29}(n,\alpha)Mg^{26}$ was recorded. An excitation energy range from 0.6 Mev was measured for the transitions to excited levels of Mg^{26}. For the reaction $Si^{28}(n,\alpha)Mg^{25}$ the transition to the ground state and to the first excited state was recorded. (tr-auth)

23131 LOW-ENERGY γ RADIATION IN THE CAPTURE OF THERMAL NEUTRONS BY RHODIUM. Gerd Buschhorn (Technische Hochschule. Laboratorium für Technische Physik, Munich). Z. Naturforsch., 17a: 241-8 (Mar. 1962). (In German)

The low-energy capture γ-ray spectrum of Rh^{104} was investigated by means of a 4.6-m bent-crystal spectrometer in DuMond arrangement. For 39 γ rays in the range from 20 to 400 kev, the energies and absolute intensities (relative to 100 neutron captures) were determined. An improved intensity calibration of the spectrometer showed the energy dependence of the integrated reflection coefficient for the (101) planes of the 3-mm thick quartz crystal in the second diffraction order to be $E^{-1.025 \pm 0.03}$ in the energy range from 100 to 470 kev. Decay-time measurements showed that besides the well known 51.4 kev E1 γ transition, a second transition with 97.1 kev also decays with the Rh^{104m} half life of 4.4 min. This 97.1 kev γ ray corresponds to the transition from the second excited Rh^{104} level to the ground state. Several Ritz combinations confirm this conclusion and improve the low-energy level scheme of Rh^{104}. (auth)

23132 DETECTION OF THE HYPERFINE STRUCTURE SPLITTING OF THE 8.42-kev γ RAY OF Tm^{169} WITH THE MÖSSBAUER EFFECT IN Tm_2O_3. Michael Kalvius (Technische Hochschule. Laboratorium für Technische Physik, Munich). Z. Naturforsch., 17a: 248-59 (Mar. 1962). (In German)

The recoilless nuclear resonance absorption of the 8.42 kev γ ray of Tm^{169} in the oxide crystal was investigated. The source (Er_2O_3) and the absorber (Tm_2O_3) were kept at room temperature. The measured Mössbauer spectrum indicates pure quadrupole splitting of the 8.42-kev nuclear level of Tm^{169} for the thulium ions with a C_2 symmetry as well as for those with C_{3i} symmetry. The energy of the electric interaction was found to be $W_{e1}(C_2) = 8 \times 10^{-7}$ ev and $W_{e1}(C_{3i}) = 1.9 \times 10^{-6}$ ev. (auth)

23133 NOTE ON THE CROSS SECTIONS FOR $Ti^{47}(n,p)Sc^{47}$ AND $Ni^{58}(n,p)Co^{58}$. A. Trier (Universidad de Chile, Santiago). Z. Naturforsch., 17a: 275-7 (Mar. 1962). (In English)

The results of some calculations for $Ti^{47}(n,p)Sc^{47}$ and $Ni^{58}(n,p)Co^{58}$ are presented in which the statistical model is assumed to be valid for the compound nucleus only and the (n,p) reaction is treated in analogy to inelastic neutron scattering to the ground state (or to the ground plus first excited state) of the residual nucleus. The calculated and experimental values are compared. There is no agreement between calculation and experiment. (J.S.R.)

23134 ABSORPTION OF π MESONS BY NUCLEI. P. Huguenin (Universität, Bonn). Z. Physik 167: 416-38 (1962). (In German)

The quantized pion field in the presence of an external electromagnetic field is first treated. Then the probability of the absorption of pions by nuclei, followed by the emission of two nucleons, is evaluated without introducing adjustable parameters or singular two-body forces (repulsive core) between nucleons. This calculation yields results whose order of magnitude agrees with the available data, and whose form corresponds to the semi-empirical formulas in use. (auth)

23135 THE DETERMINATION OF THE NUCLEAR QUADRUPOLE MOMENTS OF THE 247-kev LEVEL OF CADMIUM-111 BY MEASUREMENT OF THE CIRCULAR POLARIZATION OF γ RADIATION. H.-J. Behrend and D. Budnick (Inst. for Experimental Physics, Hamburg). Z. Physik, 168: 155-68 (1962). (In German)

The interaction of the nuclear electric quadrupole moment with an electric field gradient at the position of the nucleus changes the angular correlation of two successive γ rays and also produces a circular polarization of the γ rays. By measuring this polarization it is possible to distinguish between electric and magnetic attenuation of the γ cascade. In the electric case this measurement determines not only the absolute value of the interaction product $Q \times (\partial E/\partial z)$ but also the sign of it and therefore the sign of the nuclear quadrupole moment. The measurement of the circular polarization of the 247 kev γ ray of Cd^{111} is described. A polarization of $P = (0.8 \pm 0.2)\%$ led to the determination of the quadrupole moment of the first excited state as $Q = +0.9 \cdot 10^{-24}$ cm^2. (auth)

23136 CONTRIBUTION OF COLLECTIVE MOTION TO THE LIFTING OF l-FORBIDDENNESS. E. Ye. Berlovich, Yu. K. Gusyev, V. V. Ilyin, V. V. Nikitin, and M. K. Nikitin. Zhur. Eksptl'. i Teoret. Fiz., 42: 967-72 (Apr. 1962). (In Russian)

The lifetimes of M1 transitions of the $g_{9/2} \rightarrow d_{5/2}$ type are studied for Eu^{147}, Eu^{149}, and Eu^{151} spherical nuclei situated directly below the deformation region. The half lives of the first excited states ($g_{9/2}$) for these nuclei are respectively $(1.8 \pm 0.2) \times 10^{-10}$, $(3.2 \pm 0.2) \times 10^{-10}$ and $(3.4 \pm 0.2) \times 10^{-9}$ sec and the M1 delay factors are 115, 78, and 47 in contrast to the mean value ~300 for other known single-proton M1 transitions forbidden in l. The observed small values of the delay factors and their monotonous decrease with approach to the deformation region seems to indicate that the contribution of the collective motion becomes more significant and correspondingly the l forbiddenness becomes weaker. (auth)

23137 ANOMALOUS α-EMITTERS IN THE Po–Ra REGION. V. A. Karnaukhov (Joint Inst. of Nuclear Research,

Dubna, U.S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 42: 973-8 (Apr. 1962). (In Russian)

Emitters of 7- to 12-Mev α particles produced by irradiating lead isotopes with accelerated carbon ions are investigated. Within the experimental errors the half lives of α emitters with energies of 7.2 ± 0.2 and 8.8 ± 0.2 Mev are the same (25 to 26 sec). It is concluded that the radiation is produced in the decay of the Po^{211m} isomer. The half life of the emitter of 11.7 ± 0.3-Mev α particles is 47 ± 10 sec. The yields of the indicated emitters as a function of ion energy and nature of the target are measured. It is suggested that the 11.7-Mev radiation is caused by decay of a hitherto unknown Rn^{214} nucleus in the isomer state. Alpha decay of this nucleus is anomalously forbidden. The forbiddenness coefficient is $\sim 10^{14}$. (auth)

23138 ENERGY DEPENDENCE OF THE CROSS SECTIONS FOR (n,γ)-REACTIONS OF A NUMBER OF ODD-Z NUCLEI. Yu. P. Popov and F. L. Shapiro (Lebedev Inst. of Physics, Moscow). Zhur. Eksptl'. i Teoret. Fiz., 42: 988-1000(Apr. 1962). (In Russian)

The energy dependences of the effective cross sections for radiative capture of neutrons with energies below 40 kev are presented for Br, Rb, Nb, Rh, In, Sb, I, Cs, Ir, and Rb^{85}-enriched Rb. The curves are obtained with a neutron spectrometer based on the slowing down time in lead. Resonances are observed in both of the Rb isotopes. Neutron shells and the proton shell with Z = 50 are found to exert a pronounced effect on the dependence of the averaged capture cross sections on the number of nucleons in the nucleus. (auth)

23139 ELASTIC PHOTOPRODUCTION OF π^0-MESONS ON CARBON AT AN ENERGY OF 155 MeV. B. B. Govorkov, S. P. Denisov, and E. V. Minarik (Lebedev Inst. of Physics, Moscow). Zhur. Eksptl'. i Teoret. Fiz., 42: 1010-12(Apr. 1962). (In Russian)

The angular dependence of the cross section for the $\gamma + C^{12} \rightarrow C^{12} + \pi^0$ reaction at a mean energy of 155 Mev is measured by recording the coincidences between the two γ quanta from the π^0 meson decay. Comparison of the experimental results with the calculations in the impulse approximation indicates that the distribution of nuclear matter in the C^{12} nucleus is the same as the charge distribution obtained by electron scattering experiments. (auth)

23140 INELASTIC SCATTERING OF DEUTERONS ON Si, Ti, AND Fe NUCLEI. Yu. V. Gofman and O. F. Nemetz (Inst. of Physics, Ukrainian S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1013-16(Apr. 1962). (In Russian)

Measurement of the angular distributions of 13.6-Mev deuterons inelastically scattered on Si, Ti, and Fe nuclei are presented. The curves rise at small scattering angles; this effect may be caused by electric interaction. (auth)

23141 A STUDY OF THE ENERGY AND ANGULAR DISTRIBUTIONS OF NEUTRONS EMITTED IN THE FISSION OF U^{235} INDUCED BY THERMAL NEUTRONS. M. V. Blinov, N. M. Kazarinov, and A. N. Protopopov. Zhur. Eksptl'. i Teoret. Fiz., 42: 1017-21(Apr. 1962). (In Russian)

The energy spectra of neutrons emitted at 0, 45, and 90° to the direction of flight of fragments in the fission of U^{235} by thermal neutrons were measured. The ratio of neutron emission probability at the angles of 0, 45, and 90° was found equal to (57 ± 0.2) : (2.9 ± 0.1) : 1. (auth)

23142 COULOMB EXCITATION OF SECOND 2^+ LEVELS IN INTERMEDIATE WEIGHT EVEN-EVEN NUCLEI. Yu. P. Gangrskii and I. Kh. Lemberg (Leningrad Inst. of Physics and Tech.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1027-8(Apr. 1962). (In Russian)

The energies of second 2^+ levels and the reduced probabilities for the corresponding transitions are determined for various even nuclei by measuring coincidences of cascade γ quanta. (auth)

23143 ENERGY SPECTRUM OF RESONANCE ABSORPTION IN ZINC OXIDE OF THE 92 kev γ-RADIATION FROM Zn^{67}. V. P. Alfimenkov, Yu. M. Ostanevich, T. Ruskov, A. V. Strelkov, F. L. Shapiro, and Yang Wu-kuang (Joint Inst. of Nuclear Research, Dubna, U.S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1029-35(Apr. 1962). (In Russian)

Doppler-shift and frequency-modulation methods are employed in a study of the Mossbauer effect for the 92-kev γ radiation from Zn^{67}, the source and filter consisting of zinc oxide. The observed magnitude of the resonance absorption reaches 2×10^{-3}, the line width being somewhat larger than the natural width. The spectrum is found to exhibit a structure which is difficult to interpret in view of the poor experimental accuracy. (auth)

23144 MÖSSBAUER EFFECT IN $Sm_2^{149}O_3$. V. P. Alfimenkov, Yu. M. Ostanevich, T. Ruskov, A. V. Strelkov, F. L. Shapiro, and Yang Wu-kuang (Joint Inst. of Nuclear Research, Dubna, U.S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1036-7(Apr. 1962). (In Russian)

The Mossbauer effect is observed for the 22-kev line from the Sm^{149} nucleus. This proves that the 22-kev transition proceeds to the ground state of Sm^{149}. The upper limit of the natural level width is determined to be $\leq 6 \times 10^{-7}$ ev. (auth)

23145 RESONANCE THEORY OF NUCLEAR REACTIONS INDUCED BY NEUTRONS WITH ENERGIES BELOW 5 Mev. I. V. Gordeev. Zhur. Eksptl'. i Teoret. Fiz., 42: 1063-74(Arp. 1962). (In Russian)

A method of excluding reaction channels, which open at a given energy and compound nucleus state, is employed to deduce the Schroedinger equation with ie-terms that automatically take into account the diverging wave in the incident scattering channel. Terms of this Hamiltonian that depend smoothly on energy are combined with dispersion terms averaged over energy and related to processes occurring via the compound nucleus. An optical Hamiltonian is thus formed. A knowledge of the formal solution of the equation is sufficient to find the diagonal transition matrix element of the exact collision problem and hence various cross sections for interaction between neutrons and nuclei. Optical penetration factors are separated in the neutron widths. The cross section for elastic scattering via the compound elastic nucleus and also the reaction cross sections can be determined from the theory. A "large resonance structure" is singled out in the "force function" of other theories. The imaginary part of the optical potential is related to the true force function, which is independent of the optical properties of the interaction. The theory is compared with experiments. (auth)

23146 ANALYTICAL PROPERTIES OF THE BOUND STATE WAVE FUNCTION FOR A SUPERPOSITION OF YUKAWA POTENTIALS. M. A. Braun (Leningrad State Univ.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1106-11(Apr. 1962). (In Russian)

It is proven that the wave function of the bound S-state for a superposition of Yukawa potentials in momentum space is an analytical function of the square of the momentum t throughout the complex plane except for a pole at the point corresponding to the bound state energy and a cut on the negative semi-axis. For $|t| \rightarrow \infty$ the wave function decreases at least as rapidly as $|t|^{-2}$. An equation is set up from which the wave function discontinuity

can be determined in a simple manner. The eigenvalues of the Schroedinger equation are determined from the condition of decrease of the discontinuity at infinity. (auth)

23147 CASCADE γ-QUANTA IN THE $Rh^{103}(n,\gamma)Rh^{104}$ REACTION. L. F. Kalinkin, A. S. Melioranskii, and I. V. Estulin (Moscow State Univ.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1149-57 (May 1962). (In Russian)

A double-crystal luminescent γ-γ coincidence spectrometer was employed to study γ cascades in the $Rh^{103}(n,\gamma)Rh^{104}$ reaction by thermal neutrons. A scheme of low lying excited levels of the odd–odd Rh^{104} nucleus and of the transition between them is set up. The multipolarities of several γ transitions with energies between 35 and 133 kev are determined. Possible spin and parity values for states with excitation energies up to 900 kev are discussed. (auth)

23148 ELASTIC SCATTERING OF 2.8 Bev/c π^- MESONS ON HYDROGEN. L. P. Kotenko, E. P. Kuznetsov, G. I. Merzon, and Yu. B. Sharov (Lebedev Inst. of Physics, Lenningrad). Zhur. Eksptl'. i Teoret. Fiz., 42: 1158-65 (May 1962). (In Russian)

Elastic scattering of 2.8 Bev/c π^- mesons on hydrogen is studied with a propane bubble chamber. Elastic interaction is shown to be predominantly of a diffraction nature. The elastic diffraction scattering cross section is $\sigma_d = (6.5 \pm 0.8)$ mb, and the cross section for all elastic processes is $\sigma_e = (7.8 \pm 0.9)$ mb. The differential cross section for elastic diffraction scattering is in good agreement with the predictions of the optical model for a nucleon envisaged as a nonrefractive and absorbing sphere with a radius $R = (1.10 \pm 0.09) \times 10^{-13}$ cm and an absorption coefficient $K = (0.71 \pm 0.19) \times 10^{13}$ cm^{-1}. (auth)

23149 ON THE NUCLEAR MATRIX ELEMENTS FOR THE La^{140} β TRANSITION. A. A. Petushkov and I. V. Estulin (Moscow State Univ.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1166-70 (May 1962). (In Russian)

Circular polarization of 1.6 Mev γ quanta accompanying La^{140} β decay with an end point energy 2.2 Mev is measured. Some conclusions can be drawn from the results regarding the magnitudes of the nuclear matrix elements and the cause of the large value of log ft for the $La^{140} \rightarrow Ce^{140}$ transition between the 3^- and 2^+ states. (auth)

23150 MAGNETIC MOMENT OF THE 23.8 kev EXCITED STATE OF THE Sn^{119} NUCLEUS. V. A. Brukhanov, N. N. Delyagin, and V. S. Shpinel (Moscow State Univ.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1183-85 (May 1962). (In Russian)

The magnetic moment of the 23.8 kev excited state of the Sn^{119} nucleus is measured by γ resonance absorption. The resonance absorption spectrum is measured with a Sn^{119m} source in tin dioxide and an absorber of tin-iron alloy (1.7% tin). A value of 0.75 ± 0.04 nuclear magnetons is obtained for the magnetic moment. The magnetic field acting on the tin nuclei in the alloy is found to equal 68 ± 2 kOe. (auth)

23151 THE INDIVIDUAL PARTICLE MOTION IN THE STRONGLY DEFORMED NUCLEI. Liu Yuan and Chu Lian-yuan (Joint Inst. of Nuclear Research, Dubna, U.S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1219-24 (May 1962). (In Russian)

The single particle eigenvalues, eigenfunctions, and effective individual particle energies for rare-earth nuclei have been studied and calculated. The values of the electric quadrupole moment and the decoupling parameter calculated with the help of the new eigenfunctions are in agreement with experimental results. (auth)

23152 RESONANCE CHARGE EXCHANGE IN ATOMIC HYDROGEN. Yu. E. Murakhver (Leningrad Inst. of Physics and Technology). Zhur. Eksptl'. i Teoret. Fiz., 42: 1241-3 (May 1962). (In Russian)

The charge exchange cross sections for protons with energies E > 0.01 ev moving in atomic hydrogen are calculated with an integral expression for probability. For 0.01 ev < E < 2.5 kev and E > 1 Mev they can be expressed by simple analytical formulas. The contribution of excited states is taken into account. Largest divergences from the results of other, less exact calculations are observed at velocities v of the order $e^2/\hbar$. (auth)

23153 THE COMPOUND NUCLEUS FORMATION TIME AND THE γ-RADIATION FROM INTERACTING NUCLEI. V. V. Babikov (Joint Inst. of Nuclear Research, Dubna, U.S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1244-8 (May 1962). (In Russian)

The main characteristics of the electromagnetic radiation of a compound system assumed to consist of two incompletely coalesced nuclei and possessing a large angular momentum are derived. An analysis of the experimental data on γ radiation in reactions involving heavy ions yields results that are in agreement with the predicted effects. The time for formation of a compound nucleus as a system in complete equilibrium is estimated to be $\tau = 10^{-14}$ to 10^{-15} sec. (auth)

23154 PRODUCTION OF CHARGED VECTOR BOSONS (X-MESONS) BY LEPTONS IN THE COULOMB FIELD OF NUCLEI. V. V. Solovov and I. S. Tsukerman. Zhur. Eksptl'. i Teoret. Fiz., 42: 1252-9 (May 1962). (In Russian)

The cross sections for $\gamma + \nu \rightarrow X^+ + \mu^-$ and $\gamma + \mu^+ \rightarrow X^+ + \bar{\nu}$ are calculated in the lowest order in weak and electromagnetic interactions. The expressions obtained are then employed to calculate the total cross sections for processes $\nu + {}_zM^A \rightarrow X^+ + \mu^-$ and $\mu^+ + {}_zM^A \rightarrow X^+ + \bar{\nu}$ by the Weizsacker–Williams method. Curves of the dependence of the cross section for X-meson production on the Fe^{56} nucleus on the incident lepton energy from the threshold up to 100 Bev are presented for X-meson masses of 0.6, 1.0, and 1.4 mp. (auth)

23155 FISSION BARRIER OF A ROTATING NUCLEUS. G. A. Pik-Pichak. Zhur. Eksptl'. i Teoret. Fiz., 42: 1294-1302 (May 1962). (In Russian)

The Coulomb and surface energy of a nucleus is calculated according to the drop model for small arbitrary deformations relative to a sphere. Expressions are found for the fission barrier and for the critical rotation energy for which the nucleus does not possess a stable state. The region of applicability of the expressions is determined. (auth)

23156 SPIN DIFFUSION AND MAGNETIC RELAXATION OF NUCLEI. G. R. Khutsishvili (Inst. of Physics, Academy of Sciences, Georgran S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1311-18 (May 1962). (In Russian)

Diffusion of a nuclear spin in crystals is studied theoretically by taking into account the presence of a diffusion barrier. An expression is obtained for the nuclear magnetic relaxation time in an ion crystal containing paramagnetic atoms. The agreement between theory and experiment is improved by taking the diffusion barrier into account. (auth)

23157 DIPOLE EXCITATIONS OF NUCLEI ACCORDING TO THE SUPERFLUID MODEL. V. V. Balashov, V. B. Belyaev, and B. N. Zakhar'ev (Moscow State Univ.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1365-70 (May 1962). (In Russian)

The nuclear dipole state is regarded as a superposition of a large number of two-quasi-particle excitations. The

energy of this state (position of the photoabsorption giant resonance) compared to the single-particle value does not practically depend on whether nucleon pairing is taken into account. The required energy increase can be attained by introducing, in addition to interaction of the pairing type, a dipole–dipole interaction between the nucleons. Ways of further developing the shell model of giant resonance in deformed nuclei are discussed. (auth)

23158 AN INVESTIGATION OF THERMAL SPIKES IN GOLD BY OBSERVING THE ENERGY SPECTRUM OF SPUTTERED ATOMS. M. W. Thompson (Atomic Energy Research Establishment, Harwell, Berks, Eng.). IAEA Preprint SM-25/55. 14p. (In English)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials held in Venice, Italy, 7-11 May 1962.

Energy distribution measurements were made for sputtered atoms ejected from gold by 43-kev Xe^+ and Ar^+ ions. Twelve per cent of the sputtered atoms from Xe^+ bombardment had times of flight exceeding 190 μsec, while in the case of Ar^+ bombardment, only 4% of the sputtered atoms was this slow. The possible production of the low-energy peak by sublimation or focused collision sequences is considered and rejected. Evaporation from thermal spikes is shown to give the energy spectrum within the experimental error, with an effective spike radius of 110 and 96 A for Xe^+ and Ar^+ bombardment, respectively. (D.L.C.)

Particle Accelerators

23159 (CERN-62-16) THE BEAM GUIDE, A DEVICE FOR THE TRANSPORT OF CHARGED PARTICLES. S. van der Meer (European Organization for Nuclear Research, Geneva). Apr. 17, 1962. 30p.

A coaxial transmission line, fed with direct current or pulsed, may be used as a focusing channel for charged particles. The particles will follow a screw-type trajectory around the inner conductor. The most important properties of the trajectories are described, and normalized diagrams are given for computing all important parameters for high-energy applications. A method of calculating the acceptance is outlined and some examples are given. It is shown that both angular acceptance and phase acceptance may be an order of magnitude higher than that of a quadrupole channel. Some remarks are made about the method of excitation and the direction in which applications might be found. (auth)

23160 (MURA-637) THE EXCITATION OF A RESONANT CAVITY BY WAVEGUIDES OF SMALL CROSS-SECTIONAL DIMENSIONS. J. Van Bladel (Midwestern Universities Research Assn., Madison, Wis. and Wisconsin. Univ., Madison). May 1, 1962. Contract AT(11-1)-384. 18p.

Two basic configurations were considered: a resonant cavity with a single input waveguide of vanishingly small cross-sectional dimensions, for which the pressure in the resonator and the reflection coefficient in the waveguide are investigated, and a cavity with an input and an output waveguide (a "filter"). The transmission properties of that structure are investigated around resonance. Scalar phenomena were considered for simplicity. (auth)

23161 (SIT-P54) MEGATRON ACCELERATOR PROGRESS REPORT. Semi-Annual Report, May 15, 1961–November 15, 1961. K. C. Rogers, W. Pak, R. Coulter, and G. Brucker (Stevens Inst. of Tech., Hoboken, N. J.). Contract DA 36-039-SC-87242. 28p. (AD-270434)

Field measurements in an air-coil betatron are presented, and their implications are discussed. Results of r-f breakdown of low pressure gas are described, and a status report is made on a cesium surface-ionization plasma generator. In addition a computational study of the capture of low energy particles into betatron orbits is included. (auth)

23162 (TID-15835) PROGRESS REPORT [ON LINEAR ACCELERATOR], JANUARY 1962 THRU MARCH 1962. Erwin R. Gaerttner (Rensselaer Polytechnic Inst., Troy, N. Y.). Apr. 5, 1962. Contract AT(30-3)-328. 8p.

Two hundred and thirty hours of klystron operation were realized. Progress on the following research is reported: die-away experiments, pulsed neutron-slow chopper spectrum measurements, neutron capture cross section measurements, space and energy distributions of thermal neutrons, the effect of kernels on thermal diffusion parameters, thin region parameters, IBM-704 codes for physics and reactor studies, and time dependence of pulsed neutron assemblies. (M.C.G.)

23163 (TID-15983) RESONANT EXTRACTION FROM THREE-SECTOR LOW-SPIRAL CYCLOTRONS. H. G. Blosser, M. M. Gordon, and T. I. Arnette (Michigan State Univ., East Lansing). Apr. 4, 1962. Contract [AT(11-1)-872]. 92p.

Results of MSU studies of resonant extraction systems for a 40 Mev variable energy, multi-particle cyclotron are reviewed. A qualitative account is given of extraction principals. Results of numerical studies of both radial and axial motion under many varying resonant conditions are considered and, for comparison, also a corresponding non-resonant condition. Initial design studies relative to deflector hardware, performance estimates for the system, and preliminary studies of techniques for achieving improved duty cycle are reviewed. (auth)

23164 (AEC-tr-5137) ION SOURCE FOR A CYCLOTRON WITHOUT A FILAMENT. I. S. Trostin, E. G. Savinov, and B. M. Stasevich. Translated by Helen Basil (Argonne National Lab., Ill.) from Pribory i Tekh. Ekspt., No. 3, 22-5(1961). 9p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 15, abstract no. 31697.

23165 (FTD-TT-62-285) ANNULAR SYNCHROCYCLOTRON WITH RADIAL SECTORS. Miroslav Karamsin. Translated from Jaderná energie, 8: 265-71(1961). 21p.

The magnetic field configuration of the annular synchrocyclotron and the principle of strong focusing which enables the growth of stationary magnetic field are discussed. The laws of resonance and induction methods of acceleration are derived. The problems of transverse oscillation stability and resonance are also discussed. The main advantage of the annular synchrocyclotron consists in the possibility of attaining high intensity circulating particles, electrons or protons. (auth)

23166 (UCRL-Trans-842) SHIELDING AGAINST HIGH ENERGY NEUTRONS IN A RELATIVISTIC ISOCHRONOUS CYCLOTRON. H. G. Langmann. Translated by Julie Andre (Univ. of California Lawrence Radiation Lab., Berkeley) from Nukleonik, 3: 201-4(1961). 12p. (Includes original, 4p.).

This paper was previously abstracted from the original language and appears in NSA, Vol. 16, abstract no. 7188.

23167 RECONCILIATION OF THE CYCLOTRON TO AN ACCELERATION REGIME FOR MULTIPLY CHARGED IONS. G. Indreas and Y. Oganesyan. Acad. rep. populare Romîne, Inst. fiz. atomică si Inst., fiz., Studii cercetări fiz., 12: 821-3(1961). (In Rumanian)

The DH molecule and carbon, oxygen, and nitrogen ions are used to reconcile the cyclotron to an acceleration regime for multiply charged ions. (tr-auth)

23168 STUDY OF THE CHARACTERISTICS OF A PROTON BEAM ACCELERATED TO 10 Bev IN THE SYNCHROPHASOTRON. A. B. Kuznetsov and K. P. Myznikov. Atomnaya Energ., 12: 373-7(May 1962). (In Russian)

The characteristics of the accelerated beams such as the filling of the phase region with particles, the energy dispersion, particle distribution according to amplitude, radial and vertical dimensions, etc., were investigated for the purpose of extracting the particle beam from the synchrophasotron (synchrotron). The phase spread was experimentally determined by analyzing the high-frequency signal from the induced electrodes; this signal is proportional to the number of particles under the electrodes at a given time. The radial dimension of the stability zone was determined on the basis of phase resonance oscillations and was found to be equal to 2.8 cm. Study of the energy dispersion indicated that at the maximum radial phase oscillation, equal to 2.1 cm, the maximum energy dispersion amounts to ±2.8 Mev. A rotary target was used for measuring the distribution of particles according to their free oscillations in the vertical direction. (TTT)

23169 PHASE MOTION OF A PARTICLE IN AN ACCELERATOR HAVING FLUCTUATING PARAMETERS. I. L. Zel'manov, A. S. Kompaneets, and Yu. S. Sayasov (Inst. of Chemical Physics, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 143: 72-3(Mar. 1, 1962). (In Russian)

The equation for the phase oscillations of a particle in an accelerator, whose parameters are subject to small, arbitrary perturbations, can be approximated linearly as follows: $d^2q/dt^2 + \omega^2(t)q = a(t)\psi(t)$. Here q is the distance between the particle and an "ideal" synchrotron particle at the middle of an accelerating interval; ψ indicates the deviation from ideality, and $\omega^2(t)$ and a(t) are known, slowly varying functions of time expressed in dimensionless units of t/T, where T is the period of the high-frequency accelerating field. For the ideal case we have: $d^2q_0/dt^2 + \omega^2(t)q_0 = 0$. These two equations are solved by introducing the approximation that $q_0 \sim \omega^{-0.5} \cos (t \int \omega\, dt)$. An expression for the probability distribution $\phi(t,Q,\dot{Q})$ is then derived. Here $Q = q - q_0$ and $\dot{Q} = \dot{q} - \dot{q}_0$. This expression holds for any dynamic system which is characterized by a potential $1/2\ \omega^2(t)q^2$ varying slowly with time, and which is subjected to an arbitrary force $a(t)\psi(t)$. (TTT)

23170 SECONDARY BEAMS EMITTED BY LARGE ACCELERATORS. Robert Gouiran (CERN, Geneva). Inds. atomiques, 6: No. 1-2, 43-58(1962). (In French)

After a brief description of the nature and composition of the secondary particle beams, the utilization of various apparatuses which transport the beams from the target to counters (the magnets, lens, separators, collimators, and adsorbers) are explained. Future possibilities with respect to high magnetic fields in pulse coils or cryogenics are reviewed. The formulas and methods most used in beam optics are presented in the appendix. (tr-auth)

23171 A SOURCE FOR THE PRODUCTION OF POLARIZED PROTONS. G. H. Stafford (National Inst. for Research in Nuclear Science, Harwell, Berks, Eng.), J. M. Dickson, D. C. Salter, and M. K. Craddock. Nuclear Instr. & Methods, 15: 146-54(Mar. 1962). (In English)

Atomic-beam techniques are used to develop a polarized proton source for a 50-Mev proton linear accelerator. An accelerated beam with an intensity of 7.5×10^7 protons per second and a polarization of 0.32 is obtained. The construction of the source, its installation on the accelerator, and operating experience are discussed. Systematic errors that arise in the conventional method of making asymmetry measurements are reduced because of the ability to change the direction of the beam polarization by reversing the magnetic field across the ionizer in the source. Backgrounds are low, typically 1 part in 1000. The energy resolution is ±0.15 Mev and the energy of the beam can be readily adjusted. (auth)

23172 A 200-kv COCKCROFT-WALTON TYPE ACCELERATOR USING SELENIUM RECTIFIERS. Ryuhei Kato and Toshihiko Kōno (Ritumeikan Univ., Kyoto). Nuclear Instr. & Methods, 15: 197-9(Mar. 1962). (In English)

A 200-kv Cockcroft-Walton accelerator is constructed, principally to generate neutrons. Its high-tension generator consists of a one-stage voltage multiplier with two large selenium rectifiers capable of withstanding high voltage. The observed features of the voltage stabilization, ripple, and waveform are discussed by comparing them to theory. (auth)

23173 IRRADIATION WITHIN THE BETATRON ACCELERATION CHAMBER. L. V. Chepel, B. I. Viting, and B. A. Chapyzhnikov (Inst. of Physics and Chemistry, USSR). Pribory i Tekh. Eksp't., No. 2, 23-6(Mar.-Apr. 1962). (In Russian)

Two methods of irradiative solid and liquid specimens within a betatron acceleration chamber are described. The methods are capable of increasing the induced activity of specimens 20 to 100 folds depending on the specimen volume. (tr-auth)

23174 OBORUDOVANYE DLYA YADERNYKH ISSLEDOVANII. (Equipment for Nuclear Research). L. F. Kondrashev and N. N. Khaldin. Moscow, Gosatomizdat, 1961. 147p.

The design, construction, and operation of cyclotrons and equipment used in cyclotron experiments are described. Vacuum systems, remote control devices, and charged particle motion control devices are discussed as well as experimental equipment for neutron studies, investigation of secondary charged particles, and analyses of acceleration chambers. The data are a compilation of practical experiences accumulated during construction and operation. (R.V.J.)

Plasma Physics and Thermonuclear Processes

23175 (AD-269379) STUDY OF ELECTROMAGNETIC INTERACTIONS IN PLASMAS. Quarterly Progress Report No. 7, July 1—September 30, 1961. R. W. Gould (California Inst. of Tech., Pasadena). Contract DA36-039-SC-85317. 37p.

Solutions to the dispersion equation for a plasma cylinder in a uniform static magnetic field and for certain specific values of the plasma parameters were obtained and these results are compared with those obtained from the quasi-static approximation. The method of solution is discussed. Experiments on electromagnetic scattering from an afterglow mercury plasma show only one resonance; the relationship between frequency and density for this resonance is in approximate agreement with the simple theory for a cold plasma. (auth)

23176 (AD-270719) EVALUATION OF KUBO'S FORMULA FOR THE IMPURITY RESISTANCE OF AN INTERACTING ELECTRON GAS. Technical Report No. 7.

J. S. Langer (California, Univ., La Jolla). [1961]. Contract NONR-2216(11). 52p.

The impurity resistance of an interacting electron gas is evaluated at low but finite temperatures. Analytic techniques for use in the zero-temperature problem are applied to the complete Kubo formula. The calculations are exact to all orders in the electron-electron interactions and to lowest order in the concentration of impurities. To lowest order in the temperature the conductivity is given correctly by the independent quasi-particle model. Corrections are discussed in detail. It is shown that the only nonvanishing term of this order which explicitly contains the correlation between two quasi-particles is independent of the impurity concentration, and thus may almost always be neglected. (auth)

23177 (NASA-TN-D-1324) ELECTRON DIFFUSION IN A TURBULENT PLASMA. Harold R. Kaufman (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). June 1962. 23p.

As the plasma changes from a laminar to a fully developed turbulent state, the electron mean free path should decrease from the laminar value to some minimum turbulent value, which is determined by energy dissipating processes in the plasma. The transitional region is defined by mean free paths between these two extremes. For the two-stream instability mechanism used, the onset of turbulence is predicted when the electron drift velocity reaches the critical value. The expected minimum mean free path for this mechanism should be roughly the minimum plasma wavelength, which is set by a rapid increase in damping. In the transitional region, the electron drift velocity should tend toward the critical value. (auth)

23178 (NP-11610) SHOCK TUBE INVESTIGATION OF THE IONIZATION OF CESIUM VAPOR. Technical Report II-30. Alan F. Haught (Princeton Univ., N. J.). Feb. 1962. Contract Nonr 1858 (20). 71p.

A conventional pressure driven shock tube was used to produce ionizing shocks in a uniformly heated test section containing argon and vaporized cesium. The radiation from the shock heated cesium vapor was used to measure the thermal ionization rate of the cesium vapor as a function of temperature and density. A number of significant differences were noted between the results obtained here and those obtained in similar experiments with inert gases. In particular, unlike for the inert gases, the luminosity profile of the ionizing cesium showed a delayed radiation overshoot. The overshoot apparently arose from the two stage nature of the ionization process and, on the basis of a qualitative model for the ionization, permitted an experimental evaluation of the temperature and density dependence of both the first stage atom-atom process and the second stage electron-atom reaction. The results are discussed in terms of the present theories of the ionization process and some suggestions are offered for future work on this problem. (auth)

23179 (NYO-7989) DIFFUSION OF A PLASMA ACROSS A MAGNETIC FIELD. Technical Memo No. 50. Lyman Spitzer, Jr. (Princeton Univ., N. J. Project Matterhorn). Aug. 3, 1957. Contract [AT(30-1)-1238]. 30p.

Diffusion of an ionized gas across a magnetic field, in the presence of fluctuating electric fields, is considered. Two main topics are discussed. First is the problem of how the diffusion rate is related to the measurable statistical properties of the plasma, particularly to correlation functions involving the electric potential, U, and second is the question of what is the physical character of the fluctuations; are they of hydromagnetic or electrostatic type? It is shown that measures of the plasma potential, U, can, in principle, yield a value for the diffusion constant, D, and can also distinguish between the two types of fluctuations. A number of basic idealizations are made. (P.C.H.)

23180 (NYO-9189) LINEARIZED THREE COMPONENT MAGNETO-HYDRODYNAMICS. Richard L. Liboff (New York Univ., New York. Inst. of Mathematical Sciences). Apr. 30, 1962. Contract AT(30-1)-1480. 24p.

A linearized three component MHD theory is given. The three components are two oppositely charged species and a neutral species. Linearized macroscopic equations are presented which in the limit of vanishing magnetic field reduce to fluid dynamical equations, and in the limit of vanishing neutral component give the Lundquist equations. The coupling of the components is frictional. The sound speed that enters is a function of the three equilibrium densities. These equations yield a dispersion relation which is tenth order in the wave speed (ω/k). The decay frequencies (i.e., $-\mathrm{Im}(\omega)$) of all ten modes are calculated to first order terms in the friction, and are found to be all isotropic. All of the modes are stable. (auth)

23181 (FTD-TT-61-2) GENERAL PROPERTIES AND PLASMAPHYSICAL RELATIONS OF THE RADIATION OF SYSTEMS WHICH MOVE WITH A VELOCITY GREATER THAN THE VELOCITY OF LIGHT. I. E. Tamm. Translated from Fiz. Szemle, 10: 323-8(1960). 20p. (AD-270781)

The radiation mechanism of systems which move with a velocity greater than the velocity of light is studied. The application of the theory to aerodynamic shock waves, Cherenkov radiation and plasma-physics is discussed. (auth)

23182 EQUATION OF THE FORCES IN THE REDUCTION BY HF FIELDS OF LOSSES BY PERPENDICULAR DIFFUSION. Térenzio Consoli and René Le Gardeur (Service de Physique Appliqueé, Section d'Ionique Générale, Saclay, France). Compt. rend., 18: 3178-80(Apr. 30, 1962). (In French)

The force exerted on a plasma exposed to crossed fields in a cavity (static magnetic and stationary electromagnetic fields) is calculated. (tr-auth)

23183 ON ONE-DIMENSIONAL MAGNETOGASDYNAMICS. Ching-Shi Liu (Northwestern Univ., Evanston, Ill.). Dissertation Abstr., 22: 3971(May 1962).

Various cases of steady, one-dimensional magnetogasdynamics were investigated. Throughout this analysis, it was assumed that the magnetic field applied is at a right angle to the flow. Solutions are presented for four specific cases, namely isentropic flow; flow with finite but constant electrical conductivity; diabatic and frictionless flow; adiabatic flow with wall friction and infinite electrical conductivity. In the case of isentropic flow, the solution was reduced to that encountered in classical gas dynamics. This was accomplished by using the sum of hydrostatic pressure and magnetic pressure as a new total pressure, and the sum of the enthalpy and the magnetic energy as a new total enthalpy. In terms of these two new variables the equation of continuity, the momentum equation, and the energy equation were found to have exactly the same form as that found in classical gas dynamics. For the assumption that the ratio of specific heats is equal to two, a complete hydraulic analogy can be achieved. When finite conductivity was considered, it was found that there was a transition region within which the velocity changes rapidly. This behavior of the electrical conductivity is analogous to that of the viscosity in classical gas dynamics. As the electrical conductivity approaches infinity, the length of this transition

region approaches zero, i.e., it forms an infinitely thin shock. As the electrical conductivity approaches zero, the length of this transition region becomes infinite as may have been expected. In the case of diabatic and frictionless flow of an infinitely conducting plasma, it was found that it was possible to express all the flow variables as a function of Karman number which was defined as the ratio of flow velocity to that of the Alfven wave. As in classical gas dynamics, the flow is choked at a critical value of the Karman number denoted by K_*, therefore, the flow can be divided into two regions, one subcritical and one supercritical. These two regions are analogous to the subsonic and supersonic flow in gas dynamics. In gas dynamics, when the gas is heated, the temperature in the subsonic region will increase for $M < 1/\sqrt{\gamma}$ and decrease for $M > 1/\sqrt{\gamma}$. When the gas is cooled, the change of temperature will be reversed. In the presence of a magnetic field, a similar temperature variation occurs in the supercritical region. The pressure experiences an entirely new behavior in the subcritical region. In the heating process, it increases if $K < 1 < K_*$ and decreases if $K_* > K > 1$. In the cooling process the reverse occurs. The variations of the other variables are similar to that in gas dynamics. The values of these variables at given values of the Karman numbers were calculated and presented graphically. When wall friction was considered, the behavior of the pressure, temperature and Mach number was entirely different from that of classical gas dynamics. The pressure increases if $K < K_{pm}$ and decreases if $K > K_{pm}$. In turn the temperature increases if $K < K_{Tm}$ and decreases if $K > K_{Tm}$. The Mach number decreases if $K < K_{Mm}$, increases when $K > K_{Mm}$. The results were based on the assumption that the plasma obeys the perfect gas law, and the particle physics such as the collision mechanism were not considered. The applicability of this analysis is valid over any region where the thermal physical properties of the plasma may be considered to behave as constants.

23184 EFFECT OF A MAGNETIC FIELD ON A SURFACE WAVE IN A CONDUCTING LIQUID. V. G. Levich and Yu. Ya. Gurevich (Inst. of Electrochemistry, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 143: 64-7(Mar. 1, 1962). (In Russian)

The effect of an external magnetic field H_0 on the propagation of a gravitational wave in a conducting liquid is considered. If the amplitude of the wave a is much smaller than the wavelength λ, the variable field k can be neglected compared to $H_0(h/H_0 \ll 1)$, and the magnetic hydrodynamic equations can be written in linear form. The solution for the surface wave is the same in form as the solution obtained in the absence of the external field H_0. The following dispersion relation is derived: $\omega\rho/k - g\rho = -H_0^2/4\pi k$. Gravitational waves with $\lambda < \lambda_{cr} = H_0^2/4\pi\rho g$ cannot propagate along the surface of the liquid. Only sufficiently long or sufficiently short waves can be propagated without damping, and the dispersion relationship does not depend on the orientation of the magnetic field with respect to the z axis. (TTT)

23185 AN EXAMPLE OF A TOROIDAL MAGNETIC FIELD DESTITUTE OF MAGNETIC SURFACES. I. M. Gel'fand, M. I. Graev, N. M. Zueva, M. S. Mikhailova, and A. I. Morozov. Doklady Akad. Nauk S.S.S.R., 143: 81-3 (Mar. 1, 1962). (In Russian)

Any non-vortex toroidal magnetic field can be divided into two regions, an internal one V_i and an external region V_e. The properties of V_i as a trap for charged particles depend on the structure of the force lines in this region. The boundary between the two regions is considered as a magnetic surface or separator. It has not been established that a magnetic surface exists in a toroid magnetic field in the case of unsymmetrical magnetic fields. Numerical computation of a non-symmetrical magnetic field given by the following scalar potential was carried out: $\psi = z + h_3 I_1(3r)\sin^3(\varphi - z) + h_0 I_0(3r)\sin^3 z$. Here h_3 and h_0 are the spiral and crimped magnetic field. It has been shown that the magnetic surfaces are disrupted at $h_3 = 3$ and $h_0 = 0.125$. More accurate values are obtained here by solving the set of differential equations $dr/dz = H_r/H_z$ and $rd\varphi/dz = H_\varphi/H_z$ at $h_3 = 3$ and $h_0 = 0.125$ where $H = \Delta\psi$. The first point had the coordinates $r = 0.01$ and $\phi = 0$, while the 53rd point near the x axis has the coordinates $r = 0.013061$ and $\phi = 0.028237$. Thus, these points do not belong to a magnetic surface. Further calculations confirm the fact that a magnetic surface does not exist. Five-place accuracy was required in the computations. (TTT)

23186 PLASMA WAVEGUIDES AS LOW LOSS STRUCTURES. A. J. Lichtenberg and J. R. Woodyard (Univ. of California, Berkeley). J. Appl. Phys., 33: 1976-9(June 1962).

The dispersion relation for propagation of an electromagnetic wave between two semi-infinite slabs of plasma is found, assuming an infinite magnetic field along the slabs. If the plasma frequency is above the applied frequency, a fast wave solution exists having a sinusoidal field distribution in the free-space region between the plasma slabs and exponential decay into the slabs. A complex plasma frequency is introduced to account for collision losses in the plasma, and, substituting this complex plasma frequency into the dispersion relationship, the attenuation constant of the wave is found. The imaginary part of the plasma frequency is computed from collision theory and gives damping smaller than that obtained using metal guides. An application to high-field linear accelerators is discussed. (auth)

23187 MAGNETIC FIELD REVERSAL BY RELATIVISTIC ELECTRONS WHICH SLOW DOWN WHILE CIRCULATING IN A UNIFORM IMPRESSED MAGNETIC FIELD. Lewi Tonks (Univ. of California, Livermore). J. Appl. Phys., 33: 1987-99(June 1962). (UCRL-5733)

The Astron E layer is studied; it is assumed that the field-reversing relativistic electrons have no radial velocity; possess a single inertial energy (mass), axial velocity, and canonical angular momentum; and are slowed by dynamic friction associated with uniform, completely ionized plasma. Scattering effects are neglected. Complete trajectory evolution is described, and iterative solution techniques used to calculate field distributions are discussed. For full-energy radii of gyration below $\frac{1}{2}$ the injection radius, unstable anomalous solutions appear. Incorporation of an E layer into a thermonuclear device is discussed. (L.N.N.)

23188 FUSION PLASMA INJECTION. William I. Linlor (Univ. of California, Livermore). J. Appl. Phys., 33: 2030-2(June 1962).

A beam of 100-kv ions (H^+ and H_2^+) was passed across a magnetic field using a crossed electric field. The Lawrence Radiation Laboratory (Livermore) 1-amp, 100-kv accelerator was used. The pressure in the crossed-field chamber was about 10^{-5} mm Hg. No difficulties were encountered to about 10 ma; the current density in the beam and the available aperture determined this upper limit. (auth)

23189 LOCALLY MAXWELLIAN SOLUTIONS FOR A "POSITRONIUM" PLASMA. H. L. Frisch (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Math. Phys., 3: 549 (May-June 1962).

Exact locally Maxwellian solutions are presented in explicit form for a neutral "positronium" plasma. The solutions correspond to a flow that is a superposition of a parallel flow, a radial expansion, and a rigid-body rotation. (auth)

23190 PLASMA CONFINEMENT BY RADIOFREQUENCY FIELDS. M. Ericson (Université, Lyon). J. phys. radium, 23: 145-8(Mar. 1962). (In French)

The force acting on the boundary of a plasma placed in a r-f field is calculated. Considering the plasma as a dielectric, the force is obtained by a thermodynamic method. Extrapolating the region of validity of this method to the neighborhood of resonance, where dissipation is of importance, it is found that the free energy has a minimum for a density very close to the resonant one. Thus the plasma adjusts its volume so as to retain the resonant density. This prediction is in agreement with experimental results. (auth)

23191 FLUCTUATIONS IN A PLASMA. II. THE NUMERICAL FACTOR IN THE COULOMB LOGARITHM. Osamu Aono (Tokyo Univ.). J. Phys. Soc. Japan, 17: 853-64(May 1962). (In English)

Considering binary collision effects and many-body correlation effects simultaneously, the cut-off procedure need not be introduced to eliminate cross-section divergences. The energy loss rate of a charged particle moving fast through the plasma and the rate of relaxation between ion and electron temperatures are shown to be calculable. (auth)

23192 ION CYCLOTRON RESONANCE IN A SLIGHTLY IONIZED GAS. Akihiro Mōri (Kyoto Univ.). J. Phys. Soc., Japan, 17: 884-5(May 1962). (In English)

A 130-ma arc discharge in hydrogen at a pressure of 0 to 5×10^{-2} Torr, in a static magnetic field of 2 to 5 kOe, is studied in a cylindrical discharge tube. A r-f coil around the tube produces a small axial r-f magnetic field and an azimuthal r-f electric field. The r-f power absorption by the discharge is measured as a function of the static magnetic field intensity, and is found to reach a maximum at the proton cyclotron resonant frequency. This frequency is used to calculate the proton collision frequency as a function of pressure. It is found that the collision frequency is almost constant below about 2.8×10^{-2} Torr, but that the collision frequency may be proportional to the pressure from 2.8 to 5.0×10^{-2} Torr. (T.F.H.)

23193 RELATIVISTIC PLASMA. Behram Kurşunoğlu (Univ. of Miami, Fla.). Nuclear Fusion, 1: 213-23(Dec. 1961). (In English)

The relativistic transport equation for a one-particle distribution function is discussed. Transverse and longitudinal oscillations of a low-density plasma in the absence of external fields are considered by neglecting the collisions. Relativistic dispersion relations are derived and compared with non-relativistic theory. (auth)

23194 ACCELERATION OF PLASMA BY TRAVELING ELECTROMAGNETIC WAVES. Jack Katzenstein (Univ. of New Mexico, Albuquerque). Nuclear Fusion, 1: 224-32 (Dec. 1961). (In English)

A plasma accelerator is proposed in which the plasma is confined in a magnetic field in the form of an accelerating cusp, the confinement resulting from the combined action of the magnetic field and the equivalent gravitational field of the acceleration. The accelerating cusp is produced by a transient wave on a suitable transmission line of constant characteristic impedance and increasing velocity of propagation. Such a transmission line is in the form of a tapered solenoid suitably loaded with distributed capacitance to preserve constant characteristic impedance. An order-of-magnitude calculation of the performance of such a line is made; a line 3 m long with a characteristic impedance of 12.6 ohms and an applied voltage of 300 kv can accelerate 10^{17} deuterons to 50 kev. Possible experiments on the confinement of hot plasmas using such an accelerator are described. (auth)

23195 DIAGNOSTICS OF THE CONFINEMENT AND HEATING OF A PLASMA BY A RISING AXIAL MAGNETIC FIELD (ORTHOGONAL PINCH). J. W. Mather (Los Alamos Scientific Lab., N. Mex.). Nuclear Fusion, 1: 233-56(Dec. 1961). (In English)

Heating and confinement of a deuterium plasma by a rising axial magnetic field in cylindrical geometry is investigated as a function of applied voltage, mirror ratio (R_m), discharge tube material, and tube shape for scaling geometries at a given aspect ratio D/L = 0.44. Diagnostic methods include internal and external magnetic probes, fast streak photography, and magnetic flux and neutron measurements. Magnetic probes show the existence of trapped reverse fields and the subsequent intermixing of plasma and field during the second half and later compression cycles. Plasma confinement from the walls during the second and third half-discharge cycle is inferred from streak photographs and the duration of neutron production. As the mirror ratio is reduced to ~1, the yield and duration of neutron production increase while plasma end streaming is enhanced. Azimuthal asymmetries in the axial field in the mirror are associated with neutron production. Reducing the θ-asymmetry to ~1% reduces production by a factor of ~3. The main effects of the small field perturbations may be explained in terms of the nonuniform formation and detachment of the current sheath from the discharge tube walls. This can lead to the influx of wall impurities which may account for the lower nuclear yields. (auth)

23196 A PARAMETER STUDY OF MAGNETIC COMPRESSION OF PLASMAS WITH END LOSSES. A. C. Kolb, W. R. Faust, and A. D. Anderson (Naval Research Lab., Washington, D. C.). Nuclear Fusion, 1: 257-63(Dec. 1961). (In English)

Numerical calculations of the adiabatic compression of a collision-dominated plasma in finite, single-turn coils were carried out using the initial β and plasma state as parameters. The end losses drastically influenced the character of the discharge, as is observed experimentally. However, the measured heating rate for the electrons is much higher than predicted, pointing to an additional heating mechanism, presumably involving the dissipation of an initially trapped reverse magnetic field in the plasma. (auth)

23197 ENERGY DISTRIBUTIONS OF PROTONS IN DCX. C. F. Barnett, J. L. Dunlap, R. S. Edwards, G. R. Haste, J. A. Ray, R. G. Reinhardt, W. J. Schill, R. M. Warner, and E. R. Wells (Oak Ridge National Lab., Tenn.). Nuclear Fusion, 1: 264-72(Dec. 1961). (In English)

A particle spectrometer was used to measure energy distributions of neutral hydrogen atoms escaping from the 300-kev proton storage ring in DCX as the result of electron capture collisions between trapped protons and background gas molecules. Some atoms were converted to protons by passage through an argon-filled gas cell, and the proton beam was then electrostatically analyzed. Energy distributions of the circulating protons were obtained by transformations applied to the measured distributions. For both gas and carbon arc dissociation, the energy distributions were strong functions of the injected H_2^+ current and the location of the region of sampling relative to the median

plane. Curves illustrating these dependences are shown. In arc dissociation, the circulating protons lost energy at about 20 kev/ms with 0.1 mA injected current, and at twice this rate when the current was increased to 2.3 mA. Most of the 20-kev/ms loss rate is believed to be due to coulomb collisions of the circulating protons with electrons in the dissociating arc. This loss rate is within a factor of two of that calculated on the basis of loss to electrons of a Maxwellian distribution, well within the accuracy of the arc parameters used in the calculation. Mechanisms that might account for the additional energy loss rate at higher currents are suggested, but details of the origin of this loss are as yet unclear. The additional energy loss had the consequence of decreasing the mean storage time of the circulating protons. Measurements using dissociation also showed an increase in the rate of energy loss with injected current. With either arc or gas dissociation, the response of the energy distributions to changes in injected H_2^+ current indicated the presence of a non-collisional dispersing mechanism which increases in importance with increases in injected current. The nature of this mechanism is not clear. (auth)

23198 TURBULENT CONVECTION OF A PLASMA IN A MAGNETIC FIELD. B. B. Kadomtsev (Kurchatov Inst. for Atomic Energy, Academy of Sciences, Moscow). Nuclear Fusion, 1: 286-308(Dec. 1961). (In Russian)

The analogy between the convection instability of a normal liquid and the commutation instability is extended to include the non-linear flows arising as a consequence of instability. The turbulent convection of a plasma in traps with magnetic mirrors and in a discharge, with a longitudinal field of moderate strength, is examined. An explanation of peculiarities in the behavior of a plasma in experimental devices of this type is furnished. Convection arising in a plasma in the presence of a longitudinal current is discussed. On the basis of the current convection mechanism, it is possible to explain the anomalous diffusion of plasma in a positive column. (auth)

23199 ANGULAR MOMENTUM RELATIONS FOR PLASMAS IN MAGNETIC FIELDS. W. I. Linlor (Hughes Research Labs., Malibu, Calif.). Nuclear Fusion, 1: 309-11(Dec. 1961). (In English)

Canonical angular momentum allocations of plasma confined by magnetic fields are described in terms of ion and electron temperatures, particle density, observed rotation, and electric fields. Predictions of phenomena occurring when plasma is heated in various ways are possible. Centrifugal force from plasma rotation adds complications. Sheaths may form at plasma boundaries, depending on the density. (L.N.N.)

23200 TORQUE ON A PLASMA IN TERMS OF MAGNETIC STRESS. J. W. Dungey (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Nuclear Fusion, 1: 312(Dec. 1961). (In English)

Plasma rapid rotation measurements using photographs taken at 0.125-μsec intervals using a framing camera depend on the existence of a sufficient departure from the plasma axial symmetry. When the plasma breaks it apparently has angular momentum. Means by which the angular momentum is acquired are discussed on the basis of electromagnetic mechanisms for angular momentum transfer. (L.N.N.)

23201 A HIGH LIGHT-SPEED ELECTRON-OPTICAL SYSTEM FOR SPECTRAL INVESTIGATIONS OF PLASMA. M. M. Butslov, A. G. Plakhov, and V. V. Shapkin. Optics and Spectroscopy (U.S.S.R.) (English Translation), 12: 229-31(Mar. 1962).

The electron-optical system consisted of the simplest electron-optical image converter with electrostatic focusing and a magnetic quadrupole lens. Such a system is capable of changing within wide limits, the scale of the electronic image along two mutually perpendicular axes, while retaining good image quality. Such a system is efficient for spectral investigations of weakly-luminescing plasma. (auth)

23202 SOME CALCULATIONS OF THE CURRENTS IN THE IONIC CENTRIFUGE. Joseph Slepian. Proc. Natl. Acad. Sci. U. S., 48: 913-14(June 1962).

The book, "Magneto-Fluid Mechanics" by Ferraro and Plumpton, gives equations for calculating the current taken by the end plates and cylinder of the ionic centrifuge for the two types of discharge (ibid, 47: 313-19(1961)). In the first type of discharge, where the end plates take one half the positive ions emitted by the low-voltage arc, the beam of particles to the cylinder is concluded to consist of both positive ions and electrons with like number densities and like velocities, the ion velocity is at 45° to the cylinder surface, and the electron energy is zero. In the second type of discharge, where the whole ion current is carried with electrons at low voltage to the cylinder, the energy of the ions must be very high if they are not to be caught by the end plates, and then low again at the cylinder. (D.L.C.)

23203 EMISSION, ABSORPTION, AND CONDUCTIVITY OF A FULLY IONIZED GAS AT RADIO FREQUENCIES. Ludwig Oster (Yale Univ., New Haven). Revs. Modern Phys., 33: 525-43(Oct. 1961).

Derivation of the emission coefficient by a Fourier analysis of the dipole moment, the velocity, the particle acceleration, or the potential acting on the particle is described. A straight-line approximation to the hyperbolic path of the electron in the ion field and a frequency condition making certain integrals solvable by quadrature are discussed. Treatment of free-free transitions as two-body collisions is mentioned. Using quantum-mechanical solutions, results applying to the high-energy range and the r-f spectrum are stated. Coefficients remaining correct under conditions in which classical calculations break down are given for the r-f spectrum. The summary effect for an assembly of particles is obtained by integrating over the distribution function. The relation between emission and absorption is analyzed, assuming local thermodynamic equilibrium. (L.N.N.)

23204 HIGH-FREQUENCY FIELD STRENGTH MEASUREMENTS IN PLASMA BY MEANS OF THE STARK EFFECT. E. V. Lifshitz, A. I. Egorov, and O. G. Zagorodnov (Inst. of Physics and Technology, Academy of Sciences, Ukr. S.S.R., Kharkov). Ukrain. Fiz. Zhur., 6: 793-6(1961). (In Russian)

Measurements were carried out of a high-frequency electric field produced by an external source in a plasma waveguide placed in a magnetic field. The field strength was measured by the H_γ line broadening due to the Stark effect in a high-frequency electric field. Due to the low plasma density used in the experiments, line broadening, caused by effects, such as the Doppler effect, collisions, and the Stark effect connected with plasma microfields, are negligible. The advantage of this method is that, in distinction to other methods, it does not introduce perturbation into the plasma by measurements. (auth)

23205 CONNECTION OF SPECTRAL REPRODUCIBILITY WITH THE PROCESS OF INFLOW OF MATTER INTO THE PLASMA OF AN ELECTRIC CHARGE. Y. P. Pollyul. Ukrain. Fiz. Zhur., 6: 883-8(1961). (In Russian)

Spectral reproducibility, the minimal error obtained on

increasing the number of averaged results, is affected by the presence of fluctuations in the processes of inflow and in the excitation conditions of the substance. A study of the connection of special reproducibility with the processes of inflow showed that spectral reproducibility is a derivative function of the inflow. On the basis of experimental data, it is shown that there is a direct connection between the value of spectral reproducibility and the vapor pressure of elements constituting the discharge cloud, which determined the inflow of electrode material into the plasma of the electric discharge. (auth)

23206 ON SOME PECULIARITIES IN THE BEHAVIOR OF A RELATIVISTIC PLASMA WITH AN ANISOTROPIC DISTRIBUTION OF ELECTRON VELOCITIES. G. M. Zaslavskii and S. S. Moiseev. Zhur. Eksptl'. i Teoret. Fiz., 42: 1054-60(Apr. 1962). (In Russian)

The nature of cyclotron and aperiodic instabilities in a relativistic plasma is investigated. It is shown that the stability of a relativistic plasma with respect to cyclotron resonance and aperiodic instability is greater than that of a nonrelativistic plasma. (auth)

23207 CONVECTIVE INSTABILITY SPECTRUM OF A CONDUCTING MEDIUM IN A MAGNETIC FIELD. G. Z. Gerbuni and E. M. Zhukhovitskii (Perm State Univ. and Perm State Pedagogical Inst.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1122-5(Apr. 1962). (In Russian)

The conditions for vibrational convective instability of a conducting medium in a magnetic field are determined. From the example considered it can be seen that vibrational instability arises if certain criteria are satisfied. (auth)

23208 ON THE STABILITY OF MOVEMENT OF A CHARGED PARTICLE IN STELLARATOR MAGNETIC FIELD. A. A. Sharshanov (Khar'kov Inst. of Physics and Tech.). Zhur. Tekh. Fiz., 32: 395-401(Apr. 1962). (In Russian)

A stellarator-type magnetic field was used for determining the stability of particle motion in a simplified stellarator system, considering the system infinitely extended with hyperbolic magnetic lenses twisting the field. (R.V.J.)

23209 THE SHAPE OF THE MAGNETIC BREMSSTRAHLUNG ABSORPTION LINES IN PLASMA. A. A. Rukhadze and V. P. Silin (Lebedev Inst. of Physics, Moscow). Zhur. Tekh. Fiz., 32: 423-40(Apr. 1962). (In Russian)

The shape of bremsstrahlung absorption lines in nonrelativistic electron plasma ($\varkappa T < m_e c^2$) is analyzed as a function of electron velocity distribution. Electromagnetic wave coefficients of absorption are expressed by the electron distribution function. In turn the electron distribution function is determined by measuring the coefficients of absorption. Relativistic effects in electron thermal motion are considered in wave propagation at $\vartheta \approx \pi/2$ to the magnetic field. This leads to the appearance of considerable absorption even at non-relativistic temperatures. Analytical tensor properties of the dielectric penetrability of a plasma in constant magnetic field are also investigated. (R.V.J.)

23210 ELECTRON CONCENTRATION AND TEMPERATURE IN A WATER STABILIZED PLASMATRON JET. Yu. N. Konovalov and V. V. Magidson. Zhur. Tekh. Fiz., 32: 450-6(Apr. 1962). (In Russian)

Investigations are made of the H_β and H_γ circuit lines in a water-stabilized plasma jet. The circuits are described by Griem-Kolb-Shen theory on stark broadening of hydrogen lines in plasma. The H_β and H_γ lines were used for determining electron concentration in a jet axis at various plasma currents. The equilibrium temperatures corresponding to electron concentrations are calculated by means of Sachs equations. (R.V.J.)

23211 PROCEEDINGS OF THE CONFERENCE ON PLASMA PHYSICS AND CONTROLLED NUCLEAR FUSION RESEARCH, 4-9 SEPTEMBER 1961, SALZBURG, AUSTRIA. Nuclear Fusion, Suppl., 1-400(1962).

Thirty-seven papers are included from sessions I, II, and IV of the nine-session conference; separate abstracts have been prepared for 31. Of the papers abstracted separately, 21 are in English, 2 in French, and 8 in Russian. Six papers were previously abstracted in NSA. (T.F.H.)

23212 CONTROLLED NUCLEAR FUSION RESEARCH, SEPTEMBER 1961: REVIEW OF EXPERIMENTAL RESULTS. L. A. Artsimovich (Academy of Sciences, Moscow). Nuclear Fusion, Suppl., 15-20(1962). (In English)

The difficulties involved in experimental plasma research are noted. Plasma-producing and -containing systems are outlined, with particular attention to linear and theta pinches, slow toroidal discharges, stellarators, magnetic mirror machines, and machines with cusped geometry. The state of the art is discussed. (T.F.H.)

23213 CONTROLLED NUCLEAR FUSION RESEARCH, SEPTEMBER 1961: REVIEW OF THEORETICAL RESULTS. M. N. Rosenbluth (General Dynamics Corp., San Diego, Calif.). Nuclear Fusion, Suppl., 21-4(1962). (In English)

Theoretical aspects of plasma instabilities are reviewed, with particular attention to instability of hard-core pinches, stellarator pumpout, suppression of flute instabilities in magnetic mirrors and perhaps in theta pinches, Bohm diffusion, micro-instabilities, and the description of plasma by the Boltzmann equation. (T.F.H.)

23214 GAS INSULATION OF A HOT PLASMA: THEORY AND EXPERIMENT. H. Alfvén, C. G. Faelthammar, R. B. Johansson, E. A. Smårs, B. Wilner, and E. Witalis (Royal Inst. of Tech., Stockholm). Nuclear Fusion, Suppl., 33-8(1962). (In English)

The possibility is discussed of insulating plasma from walls by means of gas at high pressure in a strong magnetic field. The power lost from a plasma column by heat conduction through a surrounding gas is studied in two different models. In the first one, heat is assumed to be produced, e.g., by thermonuclear reactions, within a central core of the column. In the second model, ohmic heating is assumed to take place by a constant homogeneous electric field applied parallel to the column. With reasonable values of the magnetic field the losses by heat conduction are small. A toroidal high-current discharge at initial gas pressures up to 600 torr is studied experimentally. It is shown that it is possible to create an electrodeless circular arc discharge, which starts in a narrow channel and is surrounded by cool gas. Streak photographs indicate an increasing stability of the plasma ring with increasing gas pressure. Spectra taken from this high-pressure discharge are compared with those taken from the same apparatus under low-pressure conditions, when an ordinary fast pinch discharge takes place. The observations give clear evidence that the plasma is much more free from wall impurities in the high-pressure discharge than in the low-pressure case. Estimates of temperature, ion densities, and energy input are made. (auth)

23215 EXPERIMENTS WITH PARTLY IONIZED ROTATING PLASMAS. Bo Angerth, Lars Block, Ulf Fahleson, and Karl Soop (Royal Inst. of Tech., Stockholm). Nuclear Fusion, Suppl., 39-46(1962). (In English)

The interaction between a neutral gas and plasma moving

relative to each other is investigated by means of rotating plasmas where the current is limited by resistors in order to prevent complete ionization. The measurements include seven light gases, and the results show that the voltage across the discharge is fixed at a level that is roughly independent of current and pressure and proportional to the magnetic field, as long as the gas is incompletely ionized. For all seven gases investigated this voltage corresponds to a mean plasma velocity $\bar{v}$ given by $m_i\bar{v}^2/2 = eV_i$ where V_i is the ionization potential of the gas in question and m_i is the ion mass. Apparently the interaction between plasma and neutral gas is much stronger above this velocity than below it. (auth)

23216 ON THE DIFFUSION IN THE POSITIVE COLUMN IN A LONGITUDINAL MAGNETIC FIELD. G. V. Gierke and K. H. Woehler (Max-Planck-Institut für Physik und Astrophysik, Munich and Institut für Plasmaphysik GmpH, Garching, Ger.). Nuclear Fusion, Suppl., 47-53 (1962). (In English)

Detailed measurements on anomalous diffusion in the positive column in a longitudinal magnetic field are carried out in a discharge. The dependence of the diffusion on the magnetic field (by measurement of the longitudinal electric field) is recorded simultaneously with radial potential distributions, with the electron temperatures, and with the influence of additional radiofrequency ionization. All these measurements are compatible with several theories. Application of an additional multipolar helical or azimuthal magnetic field changes the dependence of the longitudinal electric field on the longitudinal magnetic field. In both cases the direction of the current is shown to be significant. The stabilizing and destabilizing action of the additional field and its dependence on the main magnetic field strength, the gas pressure, and the current direction are discussed. In the case of the multipolar field, effects of enhanced diffusion have been found that are not easy to explain. In the case of the additional azimuthal field there is a distinct dependence of the magnitude and sign of the azimuthal field on the critical magnetic field. (auth)

23217 PLASMA CONFINEMENT USING AN ALTERNATING MAGNETIC FIELD. H. A. Blevin and P. C. Thonemann (Culham Lab., Abingdon, Berks, Eng.). Nuclear Fusion, Suppl., 55-60(1962). (In English)

It is shown theoretically and experimentally that magnetic fields of Mc frequencies can penetrate a dense plasma if the conductivity is sufficiently high. In the presence of an external axial magnetic field, certain configurations of alternating magnetic fields lead to the diffusion of plasma toward either the walls or the axis. In the latter case, confined plasmas may be produced in which an external axial field of about 1 kgauss is reduced to zero at the axis. Examples of radial electron density profiles are presented. (auth)

23218 NON-ADIABATIC ORBITS IN A CUSPED MAGNETIC FIELD. Harold Grad and Roger Van Norton (New York Univ., New York). Nuclear Fusion, Suppl., 61-5 (1962). (In English)

The possible orbits in a magnetic field that has a low-field region can be classified into three distinct categories: highly adiabatic orbits that would be contained indefinitely were it not for diffusion into a loss cone by encounters with other particles; highly non-adiabatic orbits that undergo substantial and apparently random changes of magnetic moment passing near the zero-field region; and an intermediate class of orbits, for which the changes in adiabatic invariant on successive passes are relatively small but are found to be uncorrelated. Only the third group of particles is considered. The long-term behavior can be treated as a diffusion process in velocity space. The diffusion coefficient is given (within a numerical factor) by $D \sim \langle(\delta\mu/\mu)^2\rangle V^2/\tau$ when τ is the mean transit time and $\delta\mu/\mu$ is the proportional change in magnetic moment in one pass (obtained numerically in representative cases). This value may be compared with the Coulomb-encounter diffusion coefficient $D_c \sim V^2/\tau_c$ when τ_c is the mean collision time. In estimating $\delta\mu/\mu$ care must be taken not to confuse actual non-adiabatic variations with fluctuations arising from the magnetic moment's role as only an approximation to the true adiabatic invariant. (auth)

23219 EXPERIMENTS ON CUSP COMPRESSION. T. K. Allen, R. W. P. McWhirter, and I. J. Spalding (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nuclear Fusion, Suppl., 67-73(1962). (In English)

A fast-compression experiment in spindle cusp geometry is performed on plasma pre-ionized and pre-heated to above 10^5 °K by colliding shock waves. Two 22-cm-diameter coils are used with a 1-Mj capacitor bank to give peak magnetic fields of 100 kilogauss or more rising in 18 μs and, in clamped circuit, decaying with a time constant of 250 to 400 μs. Two forms of instability associated with acceleration during the compression phase are observed at high initial densities in hydrogen or with heavy gases. At lower pressures in hydrogen stable compression occurs. A comparison between the experimental results and theories of cusp systems is described. (auth)

23220 SOME EXPERIMENTAL STUDIES OF PLASMA INJECTED INTO A CUSPED MAGNETIC FIELD. D. C. Hagerman (Los Alamos Scientific Lab., N. Mex.). Nuclear Fusion, Suppl., 75-9(1962). (In English)

A hydromagnetic gun is used to inject an 8-μs high-β jet of helium plasma axially into a picket-fence magnetic field. The field (generated by external d-c coils) has a distance between axial cusps of 80 cm and a maximum field strength of 430 gauss. Magnetic probe studies show a high-β disturbance near the center lasting for 30 to 40 μs; this is followed by a long-lived low-β perturbation in the field. These disturbances are asymmetric about the medium plane, their configurations being consistent with a reflection of particles between the axial cusp furthest from the gun and radial cusp. Measurements of the He II 4686-Å line profile indicate an average ion energy of 100 ev, 50 to 80 μs after injection; this is observed perpendicular to the initial jet direction. This energy is consistent with the average ion injection energy of between 100 and 160 ev. Insertion of a magnetic probe decreases this observed ion energy by one-half; apparently a region of cold gas ($\approx$ 10 cm typical dimension) surrounds a probe in this plasma, thus making quantitative probe results unreliable. The electron temperature is measured in the interval between 50 and 140 μs by a comparison of the intensities of the He I lines 4921 and 4713; it shows a slight decrease with time (6 ev/100 μs) and has an average value of 17 ev. With this electron temperature plasma-field intermixing occurs in $\approx$20 μs. Since the electron temperature is constant, the ion lifetime may be estimated from the decay of the intensity of the He II line, which gives exponential ion lifetimes of 200 μs. This time is approximately equal to charge-exchange times between the injected ions and the background of neutral helium released by the gun. (auth)

23221 INVESTIGATION OF BEHAVIOR OF PLASMA IN THE "OREKH" MAGNETIC TRAP. N. G. Kovalskii, S. Y. Lukyanov, and I. M. Podgorni (Kurchatov Inst. of Atomic Energy, Academy of Sciences, Moscow). Nuclear Fusion, Suppl., 81-5(1962). (In Russian)

The system "Orekh" is an axially symmetric magnetic

trap with a field of complex form increasing towards the periphery. The maximum diameter of the vacuum chamber is 1000 mm; its height is 900 mm. The maximum value of the magnetic field in the magnetic slits is 4500 gauss. Experiments are carried out with a residual gas pressure of 2 to 4 · 10^{-7} mm Hg in the chamber. The plasma is injected along the axis of the system by a coaxial-type electrodynamic injector. The half-period of the current in the injector circuit is 3 μs. The velocities of the plasma bunches injected into the trap are measured by different methods, and found to be approximately 10^7 cm/sec. The methods used in investigating the plasma include electric and magnetic probes and calorimetric, photoelectric, and spectroscopic methods. In the course of the investigations it is shown that about 70% of the plasma injected into the trap escapes through the ring-shaped magnetic slit. The times of transit of the bunches through the axial magnetic slit are registered by the expulsion of the magnetic field from the region occupied by the bunch. The dependence of the plasma density in the central region upon the magnitude of the magnetic field strength is determined under different operating conditions for the electrodynamic injector. The plasma electron temperature is evaluated. The lifetime of the plasma in the trap is measured, and it is confirmed that the lifetime is independent of the magnetic field strength for a wide range of field values. The plasma lifetime in the trap at densities of 10^{13} to 10^{14}/cm^3 is approximately 60 μs. The results obtained are in agreement with the qualitative picture of the behavior of plasma in similar systems. (auth)

23222 PLASMA TRAPPING IN A RADIALLY INCREASING MAGNETIC FIELD. I. M. Podgorni and V. I. Sumarkov (Kurchatov Inst. of Atomic Energy, Academy of Sciences, Moscow). Nuclear Fusion, Suppl., 87-92(1962). (In Russian)

The lifetime of plasma in traps with magnetic field increasing towards the periphery is studied. Assuming that the plasma bunch injected into the trap has fully expelled the magnetic field from a specific region near the center and considering the linear dependence of the field strength, the following expression is obtained for the plasma lifetime in microseconds: $\tau = 0.7\ T^{1/4}\ (WR^2/H^2)^{1/4}$, where T is the energy in electron volts, W the bunch energy in ergs, R the trap radius in cm, and H the magnetic field in gauss. Substituting the experimental values it is shown that τ constitutes several tens of μs and depends weakly on the magnetic field strength, in agreement with experimental data. Experiments performed in order to check the applicability of the premises used in developing the equation are described. For the investigation of the process of plasma trapping, the methods used include calorimetry, magnetic probes, and ultra-high-speed photography. The diameter of the glass vacuum chamber of the trap is 20 cm. The magnetic field of the trap is created by two opposing coils. The coils are placed 7 cm apart. The strength of the magnetic field in the gap between the coils reaches 6 kgauss. For the injection of the plasma, a coaxial electrodynamic injector is used. It is shown that the distribution of thermal flow to the walls of the chamber depends strongly upon the magnetic field strength. For large magnetic fields the thermal flow to the wall, both parallel and antiparallel to the direction of the plasma injection, becomes equal. Thus, the main part of the energy escapes through the magnetic slits. The distributions, as a function of time, of the magnetic field along the axis of the symmetric trap are measured with magnetic probes. During the penetration of the bunch into the magnetic barrier a diamagnetic signal is observed. The data given by the probes located within the trap show a trapping of the magnetic field by the bunch and its displacement towards the central region of this trap. These data show the incorrectness of the assumption that the magnetic field is expelled from the central region of the trap during the initial stage of the process. Thus, the coincidence of the plasma lifetime obtained experimentally with the value obtained from the above equation appears to be merely fortuitous. The data of the magnetic probes are in agreement with data obtained with the help of ultra-high-speed photography. (auth)

23223 STABILITY OF AN INHOMOGENEOUS PLASMA IN A MAGNETIC FIELD. B. Lehnert (Royal Inst. of Tech., Stockholm). Nuclear Fusion, Suppl., 135-42(1962). (In English)

The stability of a plasma confined by a magnetic field is discussed in terms of particle orbits, in a theory applicable to a plasma separated from vacuum by a sharp boundary which is rippled by a sinusoidal perturbation. An earlier theory is reconsidered and extended to include the effects of a continuous density distribution. The gradient drift in an inhomogeneous magnetic field is deduced from the macroscopic theory. Account is also taken of drift motions along the boundary, which give rise to displacements comparable to and exceeding the wavelength of the perturbation. For small wavelengths the plasma is found to be stable against small "flute" deformations, not only for a magnetic field convex towards the plasma but also for a field concave towards the plasma. This latter situation occurs when the field gradient is strong enough and the density distribution is not very steep. For larger wavelengths steadily growing oscillations occur, but the growth rate is reduced considerably below that given by the earlier theory. Similar conclusions apply to the problem of gravitation instability. The result provides a possible explanation of the observed stability of the Van Allen radiation belts and of the absence of rapidly growing disturbances in experiments with magnetic mirrors and rotating plasma devices. (auth)

23224 FINITE LARMOR RADIUS STABILIZATION OF "WEAKLY" UNSTABLE CONFINED PLASMAS. M. N. Rosenbluth, N. A. Krall, and N. Rostoker (General Dynamics Corp., San Diego, Calif.). Nuclear Fusion, Suppl., 143-50(1962). (GA-2371). (In English)

The "modified" magnetohydrodynamic equations of motion follow from the exact plasma kinetic theory in the limit of small Larmor radius and low frequency, so that a magnetohydrodynamic prediction of instability is usually valid. However, in weakly unstable systems such as mirror machines, slowly rotating plasmas, large-aspect-ratio torii, etc., the expansion is no longer correct since the growth rate is very small, i.e., $(ka_i)^2$ may become comparable to ω/Ω_i so that the growth rate ω must also be considered a small quantity. Here Ω_i is the ion cyclotron frequency, a_i the ion gyro-radius and k the wave number of the perturbation. Several such cases—a plasma under gravity, a mirror machine, and a slowly rotating plasma—are studied. In all these cases the characteristic flute type instability is effectively stabilized if $(ka_i)^2 > \omega_H/\Omega$ where ω_H is the growth rate predicted by the hydrodynamic theory. Mirror experiments and fast-compression experiments operating in the region $(a_i/r)^2 \approx \omega_H/\Omega_i$ are discussed. The dominant physical oscillation-producing mechanism is the breakdown of the condition that ions and electrons move together across the magnetic field with characteristic velocity $v = c\delta E \times \underline{B}/B^2$, where δE is the perturbed electric field. As a result of the finite ion Larmor radius the mean electric field seen by the ions is slightly different from the elec-

trons so that their velocity across the field is different. This builds up a charge separation that is out of phase with the characteristic charge separation arising from particle drifts, which drives the flute-type instability. If $(ka_i)^2 > \omega_H/\Omega$, the result is a stable oscillation. (auth)

23225 ENERGY BALANCE IN THE ASTRON DEVICE. Nicholas C. Christofilos (Univ. of California, Livermore). Nuclear Fusion, Suppl., 159-68(1962). (In English)

Most of the energy input in the Astron thermonuclear device is injected in the form of kinetic energy of relativistic electrons required to maintain the E-layer. The ratio of the thermonuclear energy expected to be released in the device, to the input energy is of interest in order to evaluate the device for practical applications. The lifetime of the electrons in the E-layer depends on the rate of energy loss by Coulomb collisions and bremsstrahlung interaction with the plasma and by Schwinger radiation. The last is proportional to (γ^4/R^2), whereas the others are linearly proportional to the plasma density. The plasma pressure p_0 can be expressed as a function of the magnetic field at the surface of the E-layer, hence as a function of the electron energy (γV_ϕ) and the E-layer radius (R), and the ratio (β) of the plasma pressure to the pressure of the external magnetic field at the surface of the plasma, namely, $p_0 = [\beta/(1-\beta)]\,(\gamma V_\phi)^2/8\pi R^2$. As a consequence all three types of electron losses become proportional to $(1/R^2)$, whereas the rate of thermonuclear reactions per unit length of the plasma, along the axis of the E-layer, becomes proportional to (γ^4/R^2). Therefore, the ratio of the released thermonuclear energy to the input energy is only a function of the ratio β and the electron energy and is independent of the radius of the E-layer. This ratio is calculated as a function of β, optimizing the E-layer electron energy. At $\beta \cong 0.5$, the released thermonuclear energy is equal to the input energy required to maintain the E-layer. The electron energy, however, must be high enough to heat a plasma of a desired density up to the ignition temperature, and to permit the electrons to oscillate in and out of the plasma along the surface of the E-layer. The conditions required to achieve ignition temperature will be discussed. The parameters and the E-layer electron energy required for positive power gain are presented. (auth)

23226 LOSS OF CHARGED PARTICLES IN A STELLARATOR. W. Stodiek, R. A. Ellis, Jr., and J. G. Gorman (Princeton Univ., N. J.). Nuclear Fusion, Suppl., 193-8 (1962). (In English)

The confinement of plasma in a stellarator during the ohmic heating process is not in accordance with classical collisional diffusion. Observations in the B-3 stellarator yield a diffusion coefficient $D = 2 \times 10^4\, T_e/B\ cm^2/s$ (T_e in electron volts, B in kilogauss), about three times greater than that estimated on the basis of Bohm diffusion. The rate of particle loss is found to be inversely proportional to the square of the plasma diameter and to be independent of the degree of ionization. The results are discussed in relation to theoretical models concerning instabilities that possibly exist under the conditions of the experiment. (auth)

23227 DIFFUSION OF PLASMA FROM THE STELLARATOR. Robert W. Motley (Princeton Univ., N. J.). Nuclear Fusion, Suppl., 199-201(1962). (MATT-81). (In English)

Plasma currents are measured during the onset of enhanced diffusion in cold recombining stellarator plasmas. The magnitudes of the currents are found to coincide with those predicted for the growth of ion-wave instabilities, if an ion temperature much less than the electron temperature is assumed. However, when experimental conditions are adjusted to bring the electrons and ions more closely into thermal equilibrium, there is no observable increase in the magnitude of the critical currents, which observation is in accord with theory. (auth)

23228 SOME PRELIMINARY RESULTS ON CONTAINMENT TIME IN THE MODEL C STELLARATOR. D. J. Grove, R. M. Sinclair, W. Stodiek, W. L. Harries, and L. P. Goldberg (Princeton Univ., N. J.). Nuclear Fusion, Suppl., 203-6(1962). (MATT-100). (In English)

A description is given of the Model-C Stellarator, and results of experiments are presented. A comparison is made with corresponding data from the B-3 Stellarator. (auth)

23229 PROPERTIES OF A PLASMA FORMED BY THE INJECTION INTO OGRA OF A BEAM OF FAST MOLECULAR HYDROGEN IONS. G. F. Bogdanov, Yu. A. Kucheryaev, I. N. Golovin, and D. A. Panov (Kurchatov Inst. of Atomic Energy, Academy of Sciences, Moscow). Nuclear Fusion, Suppl., 215-25(1962). (In Russian)

A plasma trapped by magnetic mirrors, with a concentration of fast ions of about $10^7\ cm^{-3}$, is formed by the injection into Ogra of a H_2^+ ion beam with an energy up to 180 kev and a current strength up to 150 ma. The pressure of the residual gas at maximum currents of the injected beam does not exceed 1.5×10^{-7} mm Hg. The strength of the magnetic field in the center of the trap equals 2 to 2.7 kgauss, and the mirror ratio is 2.5 to 3. The configuration of the magnetic field is such that the ions drift around the axis of the trap in a direction coinciding with the direction of the Larmor rotation. The plasma formed in Ogra, unless special measures are taken, is unstable with respect to the formation of "tongues" stretched in longitudinal direction. Under these conditions the lifetime of the fast H^+ ions is approximately $\frac{1}{20}$ of the lifetime for charge exchange on the residual gas molecules, equaling ~10 μs at a residual pressure of 10^{-7} mm Hg. Considerable losses of electrons, which are formed when the residual gas is ionized, take place and as a consequence, the positive potential of the plasma with respect to the walls of the chamber reaches several decades of kilovolts at the maximum injection current. At the ends of the Ogra chamber, outside the space occupied by the fast ions, two equal isolated electrodes are located. The dimensions of these electrodes are chosen in such a way that the electrodes intercept the entire flux of the magnetic field passing through the middle section of the chamber. A positive potential of about 10 kv supplied to one of the electrodes, or simultaneously to both electrodes, stabilizes the plasma. The plasma acquires a symmetrical form. The lifetime of the ions increases, remaining, however, one-half to one-third shorter than the lifetime due to the recharging of the residual gas molecules. (auth)

23230 CYCLOTRON AND THERMAL RADIATIONS OF PLASMA IN OGRA. A. E. Bazhanova, V. T. Karpukhin, A. N. Karkhov, and V. I. Pistunovich (Kurchatov Inst. of Atomic Energy, Academy of Sciences, Moscow). Nuclear Fusion, Suppl., 227-32(1962). (In Russian)

The radiation by fast ions moving in the magnetic field of Ogra under "vacuum" conditions (electron density $n_e \lesssim 10^7\ cm^{-3}$) and in the presence of cold plasma ($n_e \geq 10^7\ cm^{-3}$) was investigated. Results are presented for the measurement of the resonance peaks of the magnetic field strength at the H_2^+ and H^+ ion-cyclotron frequencies and the overtones of these frequencies. At an electron density $n_e \approx 10^7\ cm^{-3}$ two peaks, corresponding to the fundamental ion cyclotron frequencies for H_2^+ and H^+, are observed. As the electron density increases, resonance peaks of the

electric field strength appear at frequencies divisible by the ion cyclotron frequencies for H_2^+ and H^+. The problem of the radiation of ions moving along a spiral in cold plasma is solved for the purpose of providing a possible qualitative explanation of the observed effect. The results of the calculations are in qualitative agreement with the shift of the maximum of the observed resonance peaks of the electric field strength. The electron radiation in the wavelength range $\lambda = 3.07$ to 4 cm is measured. The radiation intensity is a maximum at the electron cyclotron frequency ($\lambda_B = 3.7$ cm). The dependence of the electron cyclotron radiation ($\lambda_B \approx 3.68$ cm) and of the thermal radiation ($\lambda = 3.1$ cm) on the residual gas pressure in the chamber is obtained. The measurements showed that an accumulation of radiation in the chamber of "Ogra" takes place. The variation of the electron temperature with respect to the pressure is given. (auth)

23231 RADIATION AND ION ENERGY DISTRIBUTIONS OF THE DCX-1 PLASMA. J. L. Dunlap, C. F. Barnett, R. A. Dandl, and H. Postma (Oak Ridge National Lab., Tenn.). Nuclear Fusion, Suppl., 233-7(1962). (In English)

A high-energy plasma is created in the DCX mirror machine by injecting 600-kev diatomic hydrogen ions in the median plane. Dissociating collisions with residual gas molecules produce a plasma of atomic ions concentric with the magnetic axis, having a density of about 10^8 fast ions per cm^3. Electromagnetic radiation is observed by inserting an electrostatically shielded dipole antenna in the median plane outside the ring of trapped particles. In addition, the optical radiation arising from excitation of the residual gas is monitored. The frequency range of 0.150 to 1000 Mc is scanned by feeding the output of the antenna into a frequency analyzer. Some discrete frequencies are found throughout this range with no obvious correlation to any parameter except the presence of the plasma. In addition, a strong proton-cyclotron frequency of 14.65 Mc is observed, with multiples to the seventh harmonic. The envelope of the oscillations is observed by feeding the antenna output directly to an oscilloscope. The envelope is composed primarily of the cyclotron fundamental frequency, and its amplitude is directly proportional to the input H_2^+ current. Observation of the envelope as the plasma density increases from zero shows that the time for onset of the oscillations is inversely proportional to the magnitude of the H_2^+ current to the 0.8 power. The energy distributions of the circulating protons, determined by recharging the energetic neutral particles formed by electron capture collisions and sending them through an electrostatic analyzer, are also investigated as a function of H_2^+ current. For input currents of 0.1 ma the energy distributions of the protons are sharp, with mean energies of 300 kev. For H_2^+ currents of 3.5 ma the energy distributions are broad, with a mean energy of 260 kev and maximum energies of 400 kev. The observations suggest that particle bunching takes place in the plasma, probably giving rise to circumferential electric fields. (auth)

23232 CALCULATION OF ION TRAJECTORIES AND MAGNETIC FIELDS FOR THE MAGNETIC TRAPPING OF HIGH ENERGY PARTICLES. W. F. Gauster, G. G. Kelley, R. J. Mackin, Jr., and G. R. North (Oak Ridge National Lab., Tenn.). Nuclear Fusion, Suppl., 239-50(1962). (In English)

Several thermonuclear research devices generate a hot, dense plasma by the accumulation in a magnetic container of high-energy ions that are injected from outside and trapped there. A particle-trapping method whose prospects seem favorable is that of dissociating diatomic or triatomic molecular ions. The synthesis of magnetic fields with certain desired properties and the calculation of single-particle trajectories in the fields are discussed. Furthermore, consideration is given to perturbations arising from collective ion effects such as space charge, plasma diamagnetism, and the magnetic field of the input ion beam. A summary is given of these studies. The problem of injection in the plane of symmetry between a pair of magnetic mirror coils is solved by analytical and geometrical techniques. Other injection problems arise for machines with helical ion paths (for instance, DCX-2, where the aim is to minimize the helical pitch angle). Necessary concepts are developed to establish criteria of initial beam divergence and magnetic field homogeneity for maximizing path length. Ion movement in injection-duct fields and precession of the molecular-ion orbit upon reflection from a mirror are discussed. Methods are shown that can be applied to synthesize magnetic fields with a central zone homogeneous to within less than 0.1% over a length of about half the distance between the mirrors. These fields are produced by means of spaced, lumped coils and mirror coils giving mirror ratios from 2 to 5. The scheme requires also a carefully controlled field dip of about 2% at the injection point located between the mirrors and the homogeneous central zone. Under these circumstances, it appears possible to achieve a total path length of at least 80 times the length of the homogeneous zone. The collective phenomenon that might most seriously affect these results is space charge. For its effect to be negligible, it is required that the variation of the electrostatic potential energy along the axis inside of the homogeneous zone be much less than 0.1% of the trapped ion energy. A code for the rapid and accurate computation of magnetic fields is described. It proves to be especially advantageous for determining ion trajectories over extended distances in magnetic fields from arbitrary coil assemblies. (auth)

23233 THE DCX-2 PROGRAM OF PLASMA ACCUMULATION BY HIGH ENERGY INJECTION. P. R. Bell, G. G. Kelley, N. H. Lazar, and R. J. Mackin, Jr. (Oak Ridge National Lab., Tenn.). Nuclear Fusion, Suppl., 251-8(1962). (In English)

The experimental program associated with a device (DCX-2) being assembled to exploit the DCX scheme of plasma accumulation by dissociation-trapping of high-energy molecular ions is described. The long particle-containment time obtained in DCX-1 and a consideration of known instabilities indicate that a high-temperature plasma limited in density by mirror losses may be obtained in DCX-2, provided no new instabilities occur. The apparatus provides for an extended trajectory of the injected beam in the plasma region, permitting the use of much more tenuous dissociation media. Advantage is taken of the ion-pumping action of the plasma to secure pumping speeds of approximately 0.5 million liters per second. The shape and strength of the magnetic field provide containment of the trapped atomic ions governed by the adiabatic approximation. A summary is given of the theory of plasma accumulation in a machine of this type, and the requirements imposed upon the system parameters are evaluated. Existing elements of the apparatus include: a 600-kev accelerator and ion source designed to obtain 400 ma of ions in a well-organized beam, the source itself producing a continuous beam of 340 ma at 80 kev; almost-fully-ionized lithium and deuterium arcs with temperatures in the range of 10 to 50 ev. (In the deuterium arc a degree of ionization as large as 99% may be obtained. Lithium arcs of large Li^{+2} content can be operated in gas pressures as low as 4 ×

10^{-7} mm Hg. Means are found to adjust the density of the breakup column of the arc from very low densities to as high as 10^{14} cm^{-3}); and a beam-injection channel, shielded against the 12-kgauss field and highly compensated to minimize perturbation of the surrounding field. (auth)

23234 INTERACTION OF HIGH FREQUENCY ELECTROMAGNETIC FIELDS WITH PLASMA. R. A. Demirkhanov, Yu. S. Khodrev, N. I. Leontev, and T. I. Gutkin (Academy of Sciences, Moscow). Nuclear Fusion, Suppl., 259-63(1962). (In Russian)

The interaction between plasma and traveling and standing electromagnetic waves is studied within a frequency range from 0.6 to 6 Mc. The character of the damping of a high-frequency field in a plasma, which depends on the parameters of the plasma and the field, is experimentally investigated in devices having discharge tubes with toroidal and linear configurations. The influence of the high-frequency field upon the charged particle distributions in the plasma is studied. The existence of radial forces acting on plasma in a high-frequency field, and the compression of plasma toward the axis of the discharge as a result of these forces is shown. In devices with a traveling electromagnetic wave, the constant azimuthal current arising as a result of the transport of plasma electrons by the wave is investigated. The dependence of this current upon the plasma and wave parameters is found. It is shown that azimuthal currents of magnitude higher than some critical value excite instabilities of a "beam" character in the plasma. (auth)

23235 DEVELOPMENT OF A PLASMA BY INJECTION OF FAST PARTICLES. C. Gourdon and F. Prévot (Centre d'Études Nucléaires, Fontenay-aux-Roses, France). Nuclear Fusion, Suppl., 265-78(1962). (In French)

The evolution and equilibrium of very-high-temperature plasma obtained by injection of molecular ions or fast atoms are studied. A system of coupled differential equations describes the densities of ions and neutral molecules, inside and outside the plasma. This system represents the balance of the particles with the plasma assumed to be stable. Equilibrium solutions give characteristic curves, with S shape for the plasma and Z shape for the neutral gas as a function of the injected current. The two values of critical currents are derived and discussed. Molecular-ion injection and fast-atom injection are compared. The first method takes advantage of the possibility of an efficient multiple passage. Single passage, in the case of fast atoms, permits reduction of neutral gas sources. This condition is very critical for the success of this method. For the critical conditions, neutral gas density is much higher in the first case than in the second one. Therefore, it is possible to use the ion-pumping effect to reduce the value of critical current in the case of molecular-ion injection, and not possible in the case of fast-atom injection. If an auxiliary plasma at low temperature is used for trapping, a transition current can be defined above which the hot plasma increases in temperature and density if the cold plasma is cut off. Taking into account the exchange of energy between the hot and cold plasmas, the existence of optimum conditions is shown and the value of the optimum transition current is derived. Using an auxiliary plasma is of interest only with a good efficiency of multiple passage of the injected beam. Some other properties and the detailed influence of the parameters are shown in numerical results obtained with electronic computers. Evolution of the density as a function of time shows characteristic features near the critical conditions. (auth)

23236 MIRROR MACHINE EXPERIMENTS AND RELATED ATOMIC CROSS-SECTION MEASUREMENTS AT A.W.R.E., ALDERMASTON. D. R. Sweetman (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Nuclear Fusion, Suppl., 279-87(1962). (In English)

An experiment (Phoenix) is described in which a beam of 30-kev neutral atoms is injected into a magnetic mirror field with 50 kG central value and 100 kG in the mirrors. Conditions for achieving exponential build-up of the plasma density are discussed, and the significance of the initial trapping efficiency is brought out. The magnetic field is required to last for several seconds, and this may be achieved using a simple design of pancake-wound coils cooled to liquid nitrogen temperature. The low gas pressure and high pumping speed required are obtained by getter pumping using titanium evaporated on to surfaces cooled to liquid nitrogen temperature. Sticking probabilities for hydrogen of more than 0.5 are obtained by such a technique. The experiment can be operated with a low-intensity neutral source (1 ma equivalent), and the neutral atoms emitted from the plasma by charge exchange observed. At high gas pressures the intensity of the emitted neutrals, and hence the trapping efficiency, is proportional to gas pressure, but at low pressure the trapping efficiency is independent of pressure. This constant trapping efficiency at low pressure is interpreted as being a consequence of ionization of highly excited beam atoms by the $v \times B$ equivalent electric field present while the atoms traverse the magnetic bottle. The observed effect gives a trapping efficiency 400 times that arising from gas trapping at 10^{-9} torr. Subsidiary experiments with electric fields applied directly to high energy H^0 atoms indicate that much higher trapping efficiencies are possible; approximately 1.0 per cent of the beam is ionized by an electric field of only 220 kv/cm. The significance for the achievement of a thermonuclear plasma of this very efficient trapping mechanism is discussed. Also, a summary is given of atomic cross-section measurements relevant to the thermonuclear field, involving the dissociation of H_2^+ and H_3^+ by gases. The results of experiments on the dissociation of a range of molecular ions by electric fields are also given. (auth)

23237 INVESTIGATION OF PLASMA IN THE ADIABATIC "OGRENOK" TRAP. N. N. Brevnov, M. K. Romanovskii, and Yu. F. Tomashchuk (Kurchatov Inst. of Atomic Energy, Academy of Sciences, Moscow). Nuclear Fusion, Suppl., 289-98(1962). (In Russian)

Ogrenok is a cylindrical stainless steel vacuum chamber, 2 m long and with a diameter 0.5 m, located in an axially symmetric magnetic field of strength up to 3000 Oe in the center and up to 4500 Oe in the magnetic mirrors. An atomic beam of hydrogen ions with an energy of 10 kev is injected into the central part of the chamber. Two devices for the injection of the beam into the chamber are described, namely a magnetic channel and an electrostatic channel. The conditions of injection and the behavior of the ion beam within the system are investigated for both types of channels. For investigating the fast-ion beam in the magnetic mirror trap (i.e., motion and containment of ions, space charge compensation, interaction of the injected beam with residual gas and cold plasma, etc.) a beam of atomic ions, not molecular ions, is used, since this small-dimensioned system is not capable of transition into residual gas "burning-out" conditions (reaching the turn-over point). Therefore, experiments are done with an atomic-ion beam. The value of the fast-ion density in the trap varies from 10^5 to 10^7 ions per cm^3, depending upon the injected beam current. The zones of the beam reflections from the magnetic mirrors and the angles of the beam drift at the reflection are experimentally determined. The fast-ion density distribution along radius, azimuth, and length of

the system is studied. The paths of the fast ions in the trap are determined. It is shown that the fast ions go out into the mirrors earlier than is possible assuming only Coulomb scattering, and it is proved that one of the reasons for fast-ion escape into the mirrors is the presence of a local non-uniformity of the magnetic field created by the magnetic channel. It is shown that the local perturbation of the magnetic field leads to a displacement of the fast ions across the magnetic field. The escape of slow ions and electrons formed during charge exchange of the fast ions with the residual gas is investigated. The distribution of the slow ions and electrons escaping into the mirrors radially and azimuthally is studied. It is shown that the slow ions escape in the vicinity of the axis of the system. The upper boundary of the slow ions escaping into the mirrors, which is measured by the diaphragm method with a retarding potential, shifts towards lower energies with increasing radius. This behavior indicates that there is a peculiar distribution of the space charge, and consequently that there is incomplete compensation of the injected beam. It is shown that the ratio of the electron current to the slow-ion current near the axis of the system is smaller by at least one order of magnitude than the corresponding ratio when the ions are born in the volume at a given radius. The shape of the distribution curve of the current density for those electrons which escape into the mirrors and the anomalously weak electron current for small radii indicate that the electrons escape quickly across the magnetic field. The character of the ion and electron current distributions for ions and electrons which escape into the mirrors is practically independent of the pressure of the residual gas within the interval from 3×10^{-6} to 8×10^{-6} mm Hg. The method of diaphragm probes with retarding potentials yields values averaged in time for the electron and slow-ion currents. By means of oscillographic measurements it is established that there are oscillations of the charged-particle density distribution in the volume. It is shown that in the system there are cold-plasma oscillations with a frequency of 10 kc with 100% modulation and oscillations with frequencies 100 to 120 kc and 1 to 1.2 Mc with a 10 to 15% modulation. Frequencies of 100 kc and more are found in the injected fast-ion beam but the frequency 10 kc is missing. A peculiarity of the oscillations is their phasing-in, for a given radius, on the various azimuths and their phasing-in, for a given azimuth, on the various z-values. This phase behavior indicates a pulsation of the whole volume occupied by the slow ions and electrons. (auth)

23238 CYCLOTRON RESONANCE IN THE STATIC MAGNETIC FIELD OF A HELIX. H. Dreicer, H. J. Karr, E. A. Knapp, J. A. Phillips, E. J. Stovall, Jr., and J. L. Tuck (Los Alamos Scientific Lab., N. Mex.). Nuclear Fusion, Suppl., 299-312(1962). (In English)

An experimental and theoretical investigation of cyclotron resonant transfer of longitudinal to transverse energy in a static magnetic field is described. The field configuration consists of a uniform axial field, superimposed upon a transverse perturbing field of variable pitch that rotates spatially in phase with a particle in resonance. The efficiency of this device as an injector and trapping mechanism inside of a magnetic mirror geometry is studied by tracing electron orbits with a scintillator; detecting the leakage current out of the mirrors; and measuring the diamagnetic effect arising from the helical motion of trapped electrons. Numerical calculations carried out on a digital computer and analytic solutions to the equations of motion obtained for perturbing fields that closely approximate the experimental conditions are presented. These calculations, as well as the experiments, show that a resonant transfer of energy >70% from the longitudinal to the transverse direction is easily achieved. Containment time in the mirror geometry is shown to be limited by the inverse process, which causes a return of energy into the longitudinal direction. (auth)

23239 PRODUCTION OF PURE HIGH-TEMPERATURE PLASMA IN QUASI-STATIONARY SYSTEMS: PROCESSES LEADING TO THE INTRODUCTION OF IMPURITIES IN THE PLASMA. V. A. Simonov, B. N. Shvilkin, and G. P. Kutukov (Kurchatov Inst. of Atomic Energy, Academy of Sciences, Moscow). Nuclear Fusion, Suppl., 313-24(1962). (In Russian)

An investigation is reported of the interaction processes between plasma and walls, which processes lead to the intrusion of impurities into the plasma; processes of exchange of gas between the plasma and the walls are also studied. Experiments are carried out with toroidal devices stabilized by a strong magnetic field, and with devices involving a linear discharge and a theta-pinch. A pulsed mass-spectrographic apparatus, as well as conventional spectrometric and microwave methods are used. The interchange between the walls and the plasma gases in discharges in hydrogen as well as in other gases is investigated by means of the isotope method. The quantities of gas participating in the interchange during each pulse are determined. The process of adsorption by activation of the walls taking place during the discharges and the process of recombination of the gas on the walls (pump-out) are investigated. It is found that, for devices that go through a precise vacuum preconditioning technique, the intrusion of higher atomic number impurities into the hydrogen plasma takes place mainly because of two processes: catalytic chemical reaction on the walls, which are brought into an adsorptionally active state by the discharge; and micro-discharges (uni-polar arcs) occurring on those parts of the walls or diaphragms that are in contact with the plasma and that have a negative potential relative to the plasma. Investigations are made of the basic catalytic reactions on the walls, the composition and quantity of impurities that intrude into the plasma owing to these reactions, and effects of the properties of the wall material, the vacuum preconditioning technique, and the conditions of aging and discharge. The following is established: the mechanism of onset of micro-discharges; its dependence on the properties of the wall material (on the presence of the dielectric couplings and films); the composition and rate of intrusion of impurities from the cathode spots of the micro-discharges; and the regularity of propagation across the magnetic field of the plasma that carries the ions of impurities. The intrusion of impurities into the plasma depends considerably on its intensity of interaction with the walls (upon the degree of instability). At a given degree of plasma instability, an improvement of the purity can be achieved by a rational choice of the wall materials, of the construction of the discharge chamber, and of the vacuum preconditioning technique (localizing the regions of intensive interaction between the plasma and the wall, use of pure metallic materials without any surface dielectric layers and inclusions for those parts of the walls and diaphragms into which the plasma ions go, use of materials for wall construction which do not adsorb atomic or ionic hydrogen, use of materials with low carbon and oxygen content, and use of means of vacuum preconditioning and pumping-out that do not lead to the formation on the walls of contaminating surface layers). (auth)

23240 MAINTAINING ULTRA-LOW PRESSURES OF NEUTRAL GASES DURING THE ACCUMULATION OF

HIGH-TEMPERATURE PLASMA IN MAGNETIC TRAPS. Nuclear Fusion, Suppl., 325-39(1962). (In Russian)

In stationary magnetic traps with injection (Ogra and similar devices), the pumping-out speeds required for eliminating neutral gas are in the range of 1 to 200 million liters (hydrogen) per second. Pumping the gas with the required high speeds at ultra-low pressure is only possible by means of pumping arrangements located directly in the working volume of the device, the operation of which depends on the processes in the high-temperature plasma and on the interaction between the plasma and the walls. Processes of interaction of both atoms and ions with surfaces are investigated. These processes determine the possibility of maintaining ultra-high vacuum and preserving plasma purity under the operating conditions of thermonuclear devices with magnetic traps. Investigations are carried out of the gas sorption kinetics at low pressures on the restored surface of chemically active metals and on the surface of the materials of construction. The catalytic reactions of the adsorbed gases are also investigated. The gas output of the surfaces is measured during bombardment by fast particles. The peculiarities of the process of hydrogen adsorption by some metals at lower temperatures are discovered, which make possible the development of effective arrangements for ultra-high vacuum pumping of the neutral gas with high speeds. By means of these arrangements, it is possible to operate under conditions of bombardment of the adsorbing surfaces by fast particles. This process when used in the Ogra chamber allows a pumping speed of the neutral gas at the rate of 2 million liters per second. The following processes are investigated: injection of fast hydrogen ions and residual gases in various materials; diffusion of the injected atoms; and atomization of the adsorbed gas films. The conditions of feasibility of ion-pumping of gases in magnetic traps are determined using the method of accelerating secondary plasma ions and injecting them into the end electrodes (pumping rates were about 10 to 100 million liters per second). The processes of interaction of both the slow ions of hydrogen and other gases with the surface of chemically active metals at various temperatures are investigated. A method of ion-pumping of the magnetic traps is proposed, which consists of the absorption of the secondary ions of the plasma, without their acceleration, on the surfaces of the nitrogen-type pumping arrangements, which arrangements are located in the region where the secondary ions escape to the walls. This method makes possible the realization of ion-pumping with high speeds at ultra-low pressures, while excluding the possibility of avalanche-like processes of plasma pollution, which limit plasma accumulation. (auth)

23241 EFFECT OF A CONDUCTING WALL ON THE STABILITY OF MAGNETIC MIRROR CONFIGURATIONS. M. Vuillemin (Centre d'Études Nucléaires, Fontenay-aux-Roses, France). Nuclear Fusion, Suppl., 341-4(1962). (In French)

Using the energy principle derived from the magnetohydrodynamic equations of Chew, Goldberger and Low, the stability of a type of particular equilibrium with anisotropic pressure is studied, in a magnetic mirror configuration. In the case of axial symmetry without azimuthal field, the problem of minimizing the energy variation can be dealt with in a manner similar to that used in the case of a scalar pressure. It is shown that in the absence of conducting walls there is a necessary condition for stability with respect to displacements that do not modify the magnetic field. The presence of a perfectly conducting wall that intersects the field lines and that is in contact with the plasma, imposes the condition that the displacements are zero at the wall. This condition eliminates the type of movements responsible for "flute" instability. In this case, the study of stability reduces to consideration of the sign of the eigenvalues of a Sturm-Liouville equation. A sufficient condition for stability is established by seeking a lower limit of the first eigenvalue of this equation; for the plasma to be stable, it is sufficient that this limit should be positive. (auth)

23242 AN INVESTIGATION OF ELECTRON HEATING AT THE CYCLOTRON FREQUENCY. M. C. Becker, R. A. Landl, H. O. Eason, Jr., A. C. England, R. J. Kerr, and W. B. Ard (Oak Ridge National Lab., Tenn.). Nuclear Fusion, Suppl., 345-52(1962). (In English)

A microwave power source feeding a cavity in a magnetic mirror system is employed to heat electrons at the electron cyclotron frequency. The power source is a 1-kw, 13-cm, coaxial-waveguide klystron feeding the cavity in transverse electric modes. Two objectives of the study are to establish environmental plasmas for molecular injection devices, and to form an electrodeless plasma for study. The plasma is formed by microwave electric field breakdown of the 5×10^{-4} mm Hg background gas. Measured incandescence of metal powder dropped through the plasma indicates electron energy densities in the region of 10^{15} ev/cm^3. Analysis of the bremsstrahlung yields electron temperatures of 10 to 30 kev. The electron temperature estimate is corroborated by measured containment times of 20 to 80 ms. (auth)

23243 PLASMA GENERATOR. Charles C. Mack. U. S. Patent 3,040,209. June 19, 1962.

A controlled plasma generator for creating a circular or oval-shaped plasma is designed which is capable of producing a greater pinch effect than conventional toroidal or linear tubes. The plasma generator includes two electrodes encircled by a plurality of outer conductors made of hollow tubing in an oval or circular configuration. Two arcs are struck between a striking electrode and the two electrodes, and the resulting plasmas are forced apart until they are balanced in a circular configuration by the opposing magnetic field of the outer conductors. (D.L.C.)

Shielding

23244 (DC-61-2-101) POROUS SHIELD TESTS IN THE GE-OTT, CALCULATIONS AND ANALYSIS OF TEST DATA. [PART] I. F. Johnson, Jr. (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Feb. 19, 1960. Contract [AT(11-1)-171]. 33p.

An analysis was made of the in-air shielding tests of porous shields. Three porous shield test boxes were tested at the Outside Test Tank (OTT). Each of two of the boxes contained a mockup of a different type of porous shield design while the third box contained flat slabs of the same materials used in the other two boxes. At large distances from the OTT, the angular distribution of fast neutron and gamma dose rate measured in the tests of the porous shield mockups had definite irregularities which were not detected in the tests of the reference box containing the flat slabs. These angular test measurements are discussed in detail and compared with calculations based upon graphic analysis of porous shield geometry. Computer calculations of external centerline gamma and fast neutron dose rates for homogeneous descriptions of the test boxes are compared with the test measurements. Analytic values are defined which facilitate the analysis of porous shield tests. (auth)

23245 (NDL-TR-19) EFFECT OF NEUTRON INTERACTIONS WITH BLAST AND THERMAL SHIELDS ON MEASURED GAMMA DOSE. Robert J. Smith and Ralph F. Beach (Army Chemical Corps Nuclear Defense Lab., Army Chemical Center, Md.). Nov. 1961. 33p. (AD-269264)

Research is presented on the neutron effects on gamma detectors. An evaluation was made of the gamma dose resulting from neutron interaction with blast and thermal shields used to protect or support gamma detectors. The three sources of gamma rays from the shielding material were considered to be: gamma rays resulting from radiative capture of thermal neutrons; gamma rays resulting from inelastic scattering of neutrons; and gamma rays resulting from the decay of the radioactive daughters induced in the shields. Methods of predicting the gamma dose from these interactions are presented with sample calculations utilizing the prediction methods. Based upon examples presented neutron interactions with blast and thermal shields can contribute significantly to initial gamma measurements. The capture gamma dose is the most important contributor. Experimental and calculated capture gamma doses for two types of shield agreed within 6%. The induced activity contribution is negligible. (auth)

23246 SOME EXPERIMENTS AND ILLUSTRATIONS ON THE PENETRATION OF GAMMA RAYS THROUGH MATERIAL. M. v[on] Rimscha (Laboratorium für Strahlungsmesstechnik, Kiel). Kerntechnik, 4: 202-6(May 1962). (In German)

The law of gamma and x ray attenuation in material is discussed; narrow and wide beams of rays are considered. The connection is given among the various formalisms of writing the attenuation formula. The physical significance of the respective coordinate coefficients is pointed out. The experimental measurement of half-value layers is dealt with. Finally, the evaluation of the gamma dosage close to a point-shaped shielded gamma emitter is discussed as an example of application of the attenuation law. (auth)

23247 ABSORPTION OF PHOTONS FROM ACCELERATOR BREMSSTRAHLUNG IN LiH. Yu. M. Ado and V. V. Elyan (Inst. of Physics, Academy of Sciences, USSR). Pribory i Tekh. Ekspt., No. 2, 27-8(May.-Apr. 1962). (In Russian)

Absorption of photons from synchrotron bremsstrahlung by LiH was studied at 12 to 250 Mev. The obtained data are in good agreement with theory and confirm the efficiency of LiH absorbers as filters for suppressing low-energy bremsstrahlung. The measurements were carried out with a 280-Mev synchrotron. (tr-auth)

Theoretical Physics

23248 QUANTUM THEORY OF RELAXATION PROCESSES. V. M. Fain. Zhur. Eksptl'. i Teoret. Fiz., 42: 1075-83(Apr. 1962). (In Russian)

Relaxation of a system consisting of a dynamic subsystem with a finite number of degrees of freedom and discrete spectrum and of a dissipative sub-system with an infinite number of degrees of freedom and continuous spectrum is considered. A kinetic equation for the density matrix that is diagonal with respect to continuous indices of the dissipative sub-system and, generally speaking, nondiagonal with respect to discrete indices is derived from quantum theory, under the assumption that the interaction energy is small. It is also assumed that the diagonal singularity condition is fulfilled and that two time scales exist. As particular cases of the kinetic equation, particular theoretical equations are deduced, as well as the transport equations with Einstein coefficients. (auth)

23249 CRITICISM OF AN ATTEMPT TO DISPROVE THE UNCERTAINTY RELATION BETWEEN TIME AND ENERGY. V. Fok (Leningrad State Univ.). Zhur. Eksptl'. i Teoret. Fiz., 42: 1135-9(Apr. 1962). (In Russian)

A review of possible forms and interpretations of the uncertainty relation between time and energy is presented. An attempt by Aharonov and Bohm (Phys. Rev., 122: 1649 (1961)) to disprove the relation written in the form $\Delta(E' - E)\Delta t > h$ (1) is criticized. In order to refute the uncertainty relation (1) Aharonov and Bohm introduce into the Hamiltonian an interaction term involving a discontinuous function of time. This procedure, however, implies that instantaneous energy changes of a predictable amount and at a given instant can be observed, which is itself in violation of the uncertainty relation. Aharonov and Bohm's argument thus contains a logical error known as petitio principii. A correct treatment of the problem leads to relation (1). (auth)

23250 LECTURES IN THEORETICAL PHYSICS. 1. R. J. Eden, J. C. Polkinghorne, G. Kaellén, and J. J. Sakurai. New York, W. A. Benjamin, Inc., 1962. 96p.

Notes are presented from several series of lectures on complex variable theory, perturbation theory, renormalization theory, and elementary particle physics. (T.F.H.)

23251 COMPLEX VARIABLE THEORY AND ELEMENTARY PARTICLE PHYSICS. Richard J. Eden (Univ. of Cambridge, Eng.). p.1-101 of "Lectures in Theoretical Physics. 1." New York, W. A. Benjamin, Inc., 1962.

Condensed lecture notes are given. Mathematical techniques are developed for studying analyticity properties of scattering amplitudes in perturbation theory. These properties are applied to vertex parts in third order and scattering amplitudes in fourth order; the latter application leads to the Mandelstam representation. Single-variable dispersion relations are deduced for terms of arbitrary order in perturbation theory by means of the techniques developed. Partial-wave dispersion relations are derived from the Mandelstam representation, and applied to several problems in the structure of elementary particles. The use of analyticity is discussed in studies of nucleon electromagnetic form factors, π-π interactions, and π-N interactions. (T.F.H.)

23252 ANALYTIC PROPERTIES IN PERTURBATION THEORY. J. C. Polkinghorne (Univ. of Cambridge, Eng.). p.102-67 of "Lectures in Theoretical Physics. 1." New York, W. A. Benjamin, Inc., 1962.

Lecture notes are summarized that deal principally with the relationships between perturbation theory and the principles of crossing symmetry, unitarity, and analyticity, and with the uses of these concepts in the theory of elementary particles. The subjects outlined include integrals (particularly Feynman integrals); majorization; third-order vertex functions and fourth-order scattering diagrams; the Mandelstam representation for equal masses; continuation in the masses; acnodes and cusps; partial-wave dispersion relations; and production amplitudes. (T.F.H.)

23253 RENORMALIZATION THEORY. G. Kaellén (Univ. of Lund, Eng.). p.169-56 of "Lectures in Theoretical Physics. 1." New York, W. A. Benjamin, Inc., 1962.

Lectures are reviewed on the applications of renormali-

zation theory in the Lee model of field theory, in quantum electrodynamics, and in studies of the interactions of a scalar field with a c-number source (as an example). Attention is also devoted to the properties and uses of the reduction technique. (T.F.H.)

23254 ELEMENTARY PARTICLE PHYSICS. J. J. Sakurai (Univ. of Chicago). p.258-385 of "Lectures in Theoretical Physics. 1." New York, W. A. Benjamin, Inc., 1962.

Lectures are given reviewing the classifications, intrinsic properties, and symmetry properties of elementary particles. Investigations are made of pion physics, weak interactions of non-strange particles, strange particles, and several resonances. (T.F.H.)

REACTOR TECHNOLOGY

General and Miscellaneous

23255 (AERE-R-3093) FISSION GAS EMISSION DURING TEMPERATURE CHANGES IN A REACTOR. F. J. Stubbs and G. N. Walton (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Oct. 1959. 23p.

When the temperature of materials from which gas is being emitted by diffusion is increased sharply, a temporary burst of gas is observed. This may be partly explained on the basis of the diffusion equation. Some consideration is given to using this gas effect for the detection of defects in fuel. (auth)

23256 (APAE-96) SUMMARY REPORT OF PHYSICS MEASUREMENTS ON SM-1 CORE I. S. H. Weiss (Alco Products, Inc., Schenectady, N. Y.). Feb. 6, 1962. Contract AT(30-1)-2639. 213p.

All core physics experiments performed on SM-1 Core I and SM-1 Rearranged and Spiked Core I throughout core life are summarized. These measurements were obtained on site during the 16.4 MWYR lifetime of SM-1 Core I and 1.6 MWYR lifetime of SM-1 Rearranged and Spiked Core I. SM-1 Core I was the first stainless steel–UO_2 dispersion core to burn out in the Army Nuclear Power Program. Experimental techniques are described and a complete history of fuel movements in the core presented. Measurements include control rod bank positions during all core conditions, temperature and pressure coefficients, control rod calibrations, transient poison effects, source multiplication, and stuck rod positions. The effect of core rearrangement and spiking on core reactivity and core life is also reported. Applicable measurements from the SM-1 zero power experiments are included. (auth)

23257 (BAW-1248) SPECTRAL SHIFT CONTROL REACTOR BASIC PHYSICS PROGRAM. SMALL LATTICE EXPERIMENTS — HAZARD EVALUATION. T. C. Engelder and J. M. Doederlein (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.). May 1962. Contract AT(30-1)-2602. 89p.

A series of experiments designed to measure nuclear properties of lattices of slightly enriched oxide fuel materials moderated by D_2O–H_2O mixtures are described. This lattice is located in a central cavity of the LSR, a graphite moderated, highly enriched uranium fueled critical assembly. The facility modifications and operating procedures are described. The maximum credible accident is defined, and the resulting nuclear excursion and environmental hazards are analyzed. (auth)

23258 (CVNA-130) REPLICA, A MONTE CARLO CODE TO CALCULATE RESONANCE CAPTURE IN A LATTICE OF 19-ROD HEXAGONAL CLUSTERS. R. A. Dannels and S. M. Hendley (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). May 1962. For Carolinas Virginia Nuclear Power Associates, Inc., Charlotte, N. C. Contract AT(30-1)-2289. 85p.

REPLICA is a digital computer code for the IBM 704 or 7090, which uses Monte Carlo techniques to calculate the resonance escape probability for an infinite array of 19 rod bundles of fuel rods enclosed in tubes. The array of bundles may be rectangular, hexagonal, or staggered and each fuel rod may contain two regions. The code is a modification and an extension of the NYU REP code which does the calculation for an infinite array of single rods or slabs. Operating instructions and sample problems are given for both the 704 and 7090 versions. (auth)

23259 (DC-59-5-182) AIRFLOW TEST OF STAMPED MODERATOR ASSEMBLY. Bill M. McDaniel (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). May 14, 1959. Contract AT(11-1)-171. 11p.

An unclad, zirconium hydride ($N_H = 4.0$) stamped assembly 1.5 in. in diameter and 2.34 in. long with one, $\frac{1}{2}$-in. diameter cooling hole was tested for structural integrity. The test specimen was run for 100 hours with 33 cycles, each cycle consisting of a heating period of 30 minutes, a dwell period at a maximum temperature of 1200°F for 3 hours, and a cooling period to 900°F which required 30 minutes. At the completion of the test no longitudinal, radial, or surface cracks were observed by x ray, and bonding appeared to be even better than before test. (auth)

23260 (DC-59-6-15) MAINTENANCE HANDBOOK D102A CONTROL SYSTEM (33-7100). W. T. Miller and M. H. Ferguson (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). June 15, 1959. Contract AT(11-1)-171. 301p.

Descriptions, photographs, block diagrams, schematics, and specifications for power supplies, servo units, source range, intermediate range, power range, selector amplifier, shim control amplifier, safety bus circuits, temperature loop, shim and safety rods, and miscellaneous circuits for the D102A control system are given. (auth)

23261 (DC-59-6-143) HANDBOOK OF SERVICE INSTRUCTIONS–D102A CONTROL SYSTEM, RELAY, LAMP, AND METER CIRCUIT. Walter T. Miller and M. H. Ferguson (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). July 1, 1959. Contract AT(11-1)-171. 145p.

A manual of the latest revisions of the relay, lamp, and meter circuits of the D102A control system is presented replacing the original manual DC-58-4-199. The manual was revised to aid in the initial checkout of the modified control system and the servicing of the electrical and electronic components. The over-all system is broken down into smaller functional units and all terminal points and connector pins associated with the individual circuit are given. Many wire numbers, master terminal board, coupling plug, and dolly junction box destination points were added to the sketches and additional sketches are shown. (auth)

23262 (DC-60-2-209) SWIRL FLOW PRESSURE LOSSES IN CONCENTRIC RING FUEL ELEMENTS. Milestone Report, Task 4342-1-1. Thermodynamics and Mechanics Development Report 640. Lindley Manning (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Feb. 23, 1960. Contract AT(11-1)-171. 19p.

Swirl angles up to 20° were produced by canting the combs in the outer annulus of a concentric ribbon type fuel cartridge. The frictional pressure drop with canted combs was up to twice the loss with uncanted combs. (auth)

23263 (DC-60-5-33) CIRCULATING ROD REFLECTOR CONTROL WITH SILVER-IMPREGNATED BEARINGS. Alvin L. Spivak (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Mar. 1960. Contract AT (11-1)-171. 13p.

A high-temperature performance investigation of a

circulating-rod reflector control unit equipped with silver-impregnated sintered stainless bearings is reported. The testing established the feasibility of operation of a reflector-type control at temperatures in excess of 1000°F. Recommendations are given for further development of reflector-type controls. (auth)

23264 (DC-60-5-112) RESULTS OF COLD FLOW PERFORMANCE TESTS ON A ¼-SCALE HTRE 3 REACTOR-SHIELD MOCKUP. Paul W. Harper and Louis W. Habel (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Apr. 19, 1960. Contract AT(11-1)-171. 67p.

An experimental investigation was made using air at ambient temperature to determine the aerodynamic characteristics of an approximately ¼-scale model of HTRE 3. A combination of front and rear plug geometries was developed that produced a reactor flow distribution that was within ±2.5% of being constant in a radial direction. No circumferential variations in reactor flow were noted which could be attributed to the front plug inlet scroll with either 1 or 2 engine operation. Of the four front plug configurations tested, the one most similar to the HTRE 3 design, had the lowest total pressure loss. Two rear plug configurations were found unacceptable from the standpoint of both reactor flow distribution and pressure loss. A third rear plug configuration, which was chosen for the HTRE 3 design, had little effect on the reactor flow distribution produced by the front plug. In addition, the rear plug used for HTRE 3 had only about 53% of the total pressure loss of the better of the other two rear plug configurations. Several low speed runs made to determine reactor after-cooling performance indicated no significant flow deviations in the reactor flow distribution at tube Reynolds numbers approaching laminar conditions. (auth)

23265 (DC-61-2-46) CONTINUOUS SIMULATION OF REACTOR POWER OVER MANY DECADES. E. C. Eckert (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Feb. 9, 1961. Contract [AT(11-1)-171]. 38p.

A reactor simulation was developed which can operate through many decades of power level. It was particularly designed for providing startup simulation in the power plant operator trainer. Relays were used to provide a method of automatic recalibration which makes it possible to represent a variable that exceeds the normal two-decade range inherent in an analog computer. Applications of this simulator to actual startup control system analysis are discussed. (auth)

23266 (DC-61-3-128) STRESSES IN HEXAGONAL TUBES. F. E. Wells (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Mar. 27, 1961. Contract AT(11-1)-171. 8p.

Experimental work on hexagonal tubes with D/W ratios of 0.728 and 0.67 is described. Tests showed that the stresses resulting from internal pressure are a combination of bending stress and hoop stress, resulting in the maximum stress occurring on the I.D. of the tube at the thickest point. (auth)

23267 (DC-61-6-17) DESIGN, DEVELOPMENT, AND TESTING OF A 400°F GEAR-TYPE AIR MOTOR. F. W. Schnorr (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). June 1, 1961. Contract AT(11-1)-171. 68p.

The design, development, and environmental testing of a servo-type pneumatic rotary air motor for use with a nuclear reactor control system is reported. (auth)

23268 (DC-61-6-705) TRANSFER FUNCTIONS OF THE D102A2 CORE. IET No. 25. K. J. Skow (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). June 19, 1961. Contract AT(11-1)-171. 22p.

Results of frequency response measurements conducted during Phase III testing of the HTRE-3 at the Initial Engine Test Facility are presented. (auth)

23269 (DP-735) HEAVY WATER MODERATOR POWER REACTORS. Progress Report, April 1962. R. R. Hood and L. Isakoff, comps. (Du Pont de Nemours (E. I.) & Co. Atomic Energy Div., Wilmington, Del.). May 1962. Contract AT(07-2)-1. 31p.

Emphasis in the HWCTR startup program was placed on the conduct of physics tests at low power. Results of the tests are in good agreement with earlier lattice mockup experience. Temperature and void coefficients of reactivity for 19-rod clusters of natural UO_2 in D_2O were measured in exponential facilities at temperatures from 20 to 220°C. Postirradiation examinations of compacted UO_2 tubes confirmed earlier indications that little or no detrimental hydriding of the Zircaloy sheaths occurred during irradiation. Efforts to obtain acceptable corrosion resistance in Zircaloy-3 by beta heat treatment of the alloy were unsuccessful. The mechanical properties of irradiated nickel-free Zircaloy-2 were within 10% of those of irradiated Zircaloy-2 of normal nickel content. (auth)

23270 (IDO-16778) PROGRAM FOR IBM-650—REACTOR POWER TRANSIENTS. K. V. Moore (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). May 1, 1959. Contract AT(10-1)-205. 11p.

An adaptation of the differential equation subroutine IBM 4.0.011 was made for use on reactor transient problems. The purpose of this specialized program is to solve the basic space independent-nonlinear reactor equation using a ramp, step, or accelerated k input. (M.C.G.)

23271 (MND-C-2208) ANPP CODE DEVELOPMENT PROGRAM, PRESSURIZED WATER TASK PROGRESS REPORT NUMBER NINE. Period covered: August 1, 1961 to January 31, 1962. E. A. Colbeth, R. S. Hubner, D. Schweller, L. Welshans, F. D. Wenstrup, and T. M. Olsen (Martin Co. Nuclear Div., Baltimore). Feb. 1962. Contract AT(30-1)-2431. 136p.

The coding of the remaining depletion subroutines of SYBURN and the changes in the transport subroutines in TTHEOR to permit a criticality search were finished. The modified version of CELCOR that includes the effects of leakage from adjacent regions in calculating the multigroup source terms was checked out. A comparison was made of two-dimensional P1 and DSN theory results. The relative rates of convergence, running times, and accuracy were studied. The GAM code was revised to permit it to read thermal cross sections from the data tape and to write the SYBURN few-group constants on a binary tape. GAM-22, a 22-group version of the GAM program, was coded, compiled, and checked out. A code was written to compile and/or modify a nuclear data library tape to be used by GAM-type codes as thermal and fast cross section input. A code, RESINT, that uses experimental resonance integral data in improving the absorption and fission cross sections processed by CSDP was written and checked out. Critical experiments were carried out, and the cores analyzed by computer programs. (M.C.G.)

23272 (NDA-2169-3) INVESTIGATION OF WET STEAM AS A REACTOR COOLANT (CAN-2). Technical Progress Report for the Period September 1 to November 30, 1961. (United Nuclear Corp. Development Div., White Plains, N. Y.). Dec. 31, 1961. Work performed under United States–Euratom Joint Research and Development Program. Contract AT(30-1)-2828. 64p. (NYO-9843; EURAEC-258)

Theoretical heat transfer work was continued in an effort to predict phase distribution and critical heat flux data under fog flow conditions. Prediction of reported data on the basis of a simple classical droplet diffusion model met with only limited success. Assembly of a test apparatus intended to permit investigation of the behavior of a stream of water droplets in saturated or superheated steam under atmospheric pressure was completed and preliminary observations of water-steam interactions were made. Re-evaluation of critical areas of the reactor conceptual design was initiated. The revised power peaking factors increase the margin available between the maximum operating and critical heat flux, but the influence of the so-called L/D effect tends to reduce previously calculated critical heat flux values. (auth)

23273 (NYO-9790) SURVEY OF COMPONENT REQUIREMENTS AND AVAILABILITY FOR GAS-COOLED NUCLEAR REACTOR POWER PLANTS — CIRCULATORS. G. Novickis (Franklin Inst. Labs. for Research and Development, Philadelphia). Aug. 1961. Contract AT(30-1)-2512. 233p. (I-A2392-5)

Various existing circulator types suitable for primary loops of gas-cooled nuclear power plants are discussed. Operating characteristics, drive systems, structural problems, and maintenance questions are analyzed. The present state of the art is established and requirements, availability, development areas, and limiting factors are indicated. Several existing test-loop gas circulators are included in the general discussion. (auth)

23274 (WAPD-TM-320) M0176 — A FORTRAN PROGRAM TO SOLVE SEVERAL P-APPROXIMATIONS TO THE FEW GROUP NEUTRON TRANSPORT EQUATION IN SLAB GEOMETRY. R. M. Cantwell (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Apr. 1962. Contract AT(11-1)-Gen-14. 46p.

M0176 is a FORTRAN program which solves the neutron transport equation in a slab geometry in a few-group approximation. Fast groups are P-1 or P-3, while thermal groups are P-1 or double P-1. A variational P-1 thermal treatment, using a transformed SWAKRAUM representation, is included as an option. Boundary conditions are general. Eigenvalue, slowing down, or purely thermal problems are done. Strategy of solution is quite variable. (auth)

23275 (AEC-tr-5166) CLAMPING AND HOLDING DEVICE FOR NUCLEAR REACTORS. Arno Mueller and Armin Zacharis. Translation of German patent application. Dec. 5, 1961. 4p.

A moderator clamping and holding device is described for nuclear reactors. Vertical supporting bars around the moderator have bearing surfaces on which rings surrounding the moderator rest. During graphite expansion and contraction the circular shape of the moderator is maintained and the thermal expansion differential of moderator and structure is accommodated. (T.R.H.)

23276 CALCULATION OF SHIELDING FOR REACTOR CHANNELS. I. Apostol (Institutul de Fizică Atomică, Academia R.P.R., Bucharest). Acad. rep. populare Romîne, Inst. fiz. atomică si Inst. fiz., Studii cercetări fiz., 12: 775-89(1961). (In Rumanian)

The calculation of shielding for reactor channels is systematized by using the method of the attenuation section. A general attenuation formula for neutrons and primary γ radiation is used and a general formula for the attenuation of secondary γ radiation resulting from (n,γ) processes in radiative capture is established. A methodical analysis is then made of the attenuation of the emerging radiation, of the back-scattered radiation, and of the flux resulting from channel collimation. A general solution for the attenuation of radiation having any energy spectrum and a simplified solution for the attenuation of fission spectrum radiation are given. The variation of the attenuation cross section of graphite as a function of neutron energy was calculated. (tr-auth)

23277 ZONE PROFILING OF REACTORS. N. N. Ponomarev-Stepnoi. Atomnaya Energ., 12: 415-17(May 1962). (In Russian)

Technical difficulties may prevent occasionally the physical profiling of power reactors by means of a continuous variation of the fissionable material; in such cases the zone profiling method may be used to good advantage. This method which involves a sudden change of the fuel concentration from one zone to another while remaining constant within a zone can be used for determining the fuel distribution ensuring the continued operation of the reactor while the maximum permissible conditions prevail at least in one point of each zone. The method makes it possible to determine the dimensions of the regions ensuring the highest energy removal. The problem of such a zone profiling of a cylindrical reactor was studied in both lengthwise and radical directions. By optimizing the nonuniformity coefficient of the 4-zone reactor, a value of 1.135 was obtained for this coefficient instead of 1.62 for the nonprofiled reactor. From the lengthwise profiling the zone dimensions corresponding to the highest temperature of the coolant in the 4 zones were calculated, making it possible to increase the heat load of the coolant by 8%. An infinite increase of the number of the zones tends to coincide the values with those derived from continuous profiling calculations. (TTT)

23278 THE PROBLEM OF PHYSICAL PROFILING OF THE HEAT PRODUCTION IN HETEROGENEOUS POWER REACTORS. N. N. Ponomarev-Stepnoĭ and E. S. Glushkov. Atomnaya Energ., 12: 418-19(May 1962). (In Russian)

The problem of physical profiling of the heat generation in reactors was solved by the authors (Atomnaya Energ., 11: 19(1961) No. 1) by the homogeneous intermixing of the nuclei of the moderator and the fuel. However, in heterogeneous reactors the structural arrangement of the fuel elements in separate units within the moderator requires a large number of steps for the physical profiling operation than in the case of homogeneous reactors. Redistribution of the fuel may be carried out by changing the location of the fuel elements, the volume ratio of the fuel in the core, the concentration of the fissionable material in the fuel elements, and the diameter of the elements. The mathematical definitions of these conditions in heterogeneous reactors lead back to the problems considered in the above-cited article, disregarding the heterogeneous effects. Design and structural engineering considerations may limit use of the calculated optimum parametric conditions. (TTT)

23279 SOLUTION OF REACTOR EQUATIONS IN PHYSICAL PROFILING CALCULATIONS WITH ALLOWANCE FOR THE VARIABLE DENSITY OF THE MODERATOR. N. N. Ponomarev-Stepnoi and E. S. Glushkov. Atomnaya Energ., 12: 419-21(May 1962). (In Russian)

In view of the nonuniform fuel distribution in the reactor, the density of the moderator depends on its coördinates. In previous profiling studies it was assumed that the moderating and scattering properties of the core and reflector materials are not subject to such dependence. The method developed makes it possible to carry out neutron physics calculations of a reactor in the case of a lengthwise profiling of the energy generating process, i.e., under a given distribution of the fission neutron sources while taking into

account the changes in the density of the moderator material. A 2-group approximation method was used, assuming fixed energy generation in the system. The derived formula was found to be useful in actual reactor calculations. (TTT)

23280 CALCULATION OF TRANSIENT STATES IN A HYDRAULIC LOOP CONTAINING A FALLING BODY. T. A. Gruzinova, R. R. Ionaĭtis, F. T. Kamenshchikov, and D. N. Popov. Atomnaya Energ., 12: 421-3(May 1962). (In Russian)

The transient states taking place in a hydraulic loop with a vertical portion in which a multimembered body is allowed to fall were examined for the purpose of clarifying the possibility of an increase of the falling velocity in the liquid. The fall of the body must not be accompanied by a pressure drop which could cause boiling in the liquid of the loop. The flow rate of the liquid must ensure the filling of the space above the body during the fall. The dependence of the flow rate and the pressure on the falling velocity may be determined by direct measurements using a storage tank. The calculations were considerably simplified by neglecting the elasticity of the liquid and of the walls without introducing serious errors as the duration of the fall exceeded greatly the propagation rate of the shock wave in the hydraulic system. The transient states were calculated on the basis of the differential equations of liquid flow and of the motion of a solid through liquids. The initial Reynolds number was exceeded by a factor of 10 to 20 in the annulus between the body and the pipe during the fall of the body. The conditions could be controlled by placing the control tank directly next to the vertical pipe. The calculations are useful for studying the hydraulic safety system of reactors. (TTT)

23281 USE OF NONUNIFORM MODERATION TO OBTAIN FLAT FLUX AND POWER FOR NUCLEAR REACTORS AND RELATED TOPICS. Jack Martin Ravets (Cornell Univ., Ithaca, N. Y.). Dissertation Abstr., 22: 2727-8(Feb. 1962).

The flattening of the thermal flux and power can be attained in a two region nuclear reactor by nonuniformly distributing the moderator material throughout the reactor core. The fuel is uniformly distributed in such a reactor, permitting operation with all the fuel elements at the maximum allowable power levels. This increases the reactor's efficiency as compared to conventional reactors. Nonuniform moderation is discussed within the framework of two-group diffusion theory. The moderator distribution is described by a relative density function, $\rho(r)$, defined as the ratio of the mass of moderator per unit core volume to the density of pure moderator material. The general characteristic of these reactors is that $\rho(r)$ increases with increasing distance, r, from the center of the core. The increasing density distribution leads to an increased production of thermal neutrons in the region near the core-reflector interface, filling the valley in the thermal flux which normally occurs in this region. Differential equations which determine $\rho(r)$ were derived for the planar, spherical, and cylindrical geometries. Numerical methods for solving these equations, which are second order and non-linear, are discussed and the formulation of an electronic digital computer code is presented. Solutions for $\rho(r)$ along with the corresponding critical masses of fuel were determined for several typical systems having combinations of water, beryllium, graphite, and heavy water moderators and reflectors. All combinations of moderator and reflector materials cannot be used in these flat flux systems. The restrictions determining the physically allowable systems were thoroughly investigated. An approximation procedure for analytically obtaining the required moderator distribution was also derived. Here, the basic assumption made is replacement of the spatially dependent macroscopic thermal absorption cross section of the moderator by its average value over the core, in the thermal diffusion equation. This rendered the exact nonlinear equation for $\rho(r)$ integrable. A comparison between the approximate and exact solutions is given, showing them to differ by only a few percent in several cases. The effects of varying the thickness of the reflector of a nonuniform reactor was investigated. The use of finite, rather than infinite, reflectors relaxes some of the allowability restrictions, smooths $\rho(r)$, and for water moderated, but not reflected, reactors reduces the required critical mass. Another method for obtaining both flat thermal flux and power is the nonuniform distribution of a strong thermal neutron absorber, or poison, throughout the core. The required poison distributions were determined on a two-group basis. It is shown that the moderator-reflector combinations that can be used are limited. To extend this list, a thin sheet of fuel, referred to as a delta-loading, can be placed at the core-reflector interface. The theory of nonuniformly poisoned, delta-loaded reactors is presented. A similar discussion is also given for nonuniformly moderated reactors with delta-loadings. In addition to the major investigations noted above, a number of related topics are treated, including: the effect of nonuniform moderator distributions on nonuniformly fueled reactors; a theorem proving that nonuniformly moderated planar reactors having flat flux also have minimum critical mass; a comparison of the critical masses of reactors having flat flux resulting from the use of nonuniform moderation, nonuniform fueling, and nonuniform thermal poisoning to similar uniform reactors; and the effects of varying the fuel enrichment of the various kinds of flat flux reactors. Finally, a preliminary investigation was made of the approaches that could be taken to extend the work.

23282 FISSION PRODUCT POISONING IN THERMAL REACTORS. V. Benzi and A. Chiarini (Comitato Nazionale per l'Energia Nucleare, Bologna). Energia nucleare (Milan), 9: 266-71(May 1962). (In English)

Following closely the methods used by Walker, the fractional yields and effective cross sections of pseudofission products for U^{233}, U^{235}, and Pu^{239} were re-evaluated on the basis of new data available. Pseudo-resonance-integrals are given, so that calculations can be made for practical values of the neutron energy spectrum parameters. (auth)

23283 THERMALIZATION THEORY IN A TWO-TEMPERATURE LATTICE. R. Bonalumi (Centro Informazioni Studi Esperienze, Milan). Energia nucleare (Milan), 9: 293-5(May 1962). (In English)

Theoretical calculations were made of the thermal neutron spectra in a two-region, two-temperature lattice where both regions contribute a slowing-down source. (M.C.G.)

23284 REACTIVITY EFFECTS PRODUCED BY FLUID MOTION IN A REACTOR CORE. Bertram Wolfe (General Electric Co., San Jose, Calif.). Nuclear Sci. and Eng., 13: 80-90(June 1962).

Expressions for the reactivity effects produced by the motion of a fluid in a reactor core are developed using perturbation techniques. It is shown that in a fixed-fuel reactor significant reactivity effects can be produced by the "drag" of the fluid on the neutron population. In a fluid-fuel reactor, the transport of the delayed neutron precursors can produce reactivity changes approaching a dollar for very moderate fluid velocities. An expression for the delayed neutron lifetime in a fluid-fuel reactor is devel-

oped, and the corresponding inhour equation is derived. (auth)

23285 AN ENGINEERING PHYSICS METHOD OF CALCULATION APPLIED TO LIGHT-WATER CRITICAL EXPERIMENTS INVESTIGATING NUCLEAR SUPERHEAT. R. W. Deutsch (General Nuclear Engineering Corp., Dunedin, Fla.). Nuclear Sci. and Eng., 13: 110-13 (June 1962).

A method of calculation is used to plan and interpret critical experiments that simulate a boiling reactor and a boiling reactor with integral nuclear superheat. The boiler region contains aluminum-clad fuel rods of 1.85 wt % U^{235} enrichment and some rods of natural enrichment. The superheater region is composed of rod-in-tube elements, the fuel rod having 3.41 wt % U^{235} enrichment and a stainless steel clad. For core arrangements containing boiler fuel, the variations in reactivity and rod-by-rod power distributions produced by changing fuel, moderator, and neutron poison content within a fuel assembly are determined; also, reactivity measurements involving cadmium and boron–stainless steel control rods are used to derive effective epithermal transmission probabilities for these materials. For the boiler superheater cores, the variations in reactivity, power regulation, and rod-by-rod power distribution produced by changing the boiler–superheater arrangements, and by voiding and flooding the superheater region are determined. For most of the core arrangements, the theoretical predictions are carried out prior to the measurements. The comparison of theory with experiment indicates that the method is accurate to within the limits imposed by the uncertainty of experimental techniques, which included uncertainties in core dimensions and compositions. (auth)

23286 DEVELOPMENT OF THE SEMIHOMOGENEOUS FUEL ELEMENT FOR A GAS-COOLED REACTOR. S. A. Bernsen, H. C. Hopkins, Jr., and R. C. Howard (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nuclear Sci. and Eng., 13: 153-65 (June 1962). (GA-2275 and Rev.)

A fuel element that combined the virtues of homogeneous and heterogeneous fuel elements was conceived and tested for a gas-cooled reactor. The element consisted of small-diameter metal-clad fuel bodies inserted in graphite plates, which served as the moderator. A satisfactory design was developed after experimentation with several graphite–metal combinations, thermal expansion studies, and graphite strength tests. Two elements were tested in-pile for a total of 2500 hr at 1500°F surface temperature. The elements retained their structural integrity after the irradiation. Although small amounts of fission products were released from the elements, this leakage was not large enough to cause an operating problem during the tests. (auth)

23287 TWO METHODS OF CALCULATING FAST REACTOR CONTROL ROD EFFECT AND THEIR AGREEMENT WITH EXPERIMENT. A. D. Krumbein and J. H. Ray (United Nuclear Corp., White Plains, N. Y.). Nuclear Sci. and Eng., 13: 166-70 (June 1962).

The effect of control rod movement in a fast reactor was calculated directly by solving a series of two-dimensional multigroup problems and indirectly by using a set of danger coefficients derived from one-dimensional calculations. The values of reactivity insertion calculated by the two methods for complete safety rod withdrawal agree within three per cent. The shape of a curve of relative reactivity insertion vs. rod withdrawal distance is also predicted, with agreement between the two methods. Differences between the two predictions are within three per cent of the maximum value. Comparison of these predictions with a set of normalized experimental values shows agreement within four per cent of the maximum value. (auth)

23288 NEUTRON ABSORBER MATERIALS FOR REACTOR CONTROL. W. Kermit Anderson and J. S. Theilacker, eds. (Division of Reactor Development, AEC). 1962. 878p. $3.00 (GPO).

Information on boron, silver alloys, and rare earth compounds along with a summary of information of hafnium obtained in connection with the development of control rods and burnable poison elements is presented. The physical, chemical, and mechanical requirements for control rods and burnable poison elements which influence selection and development of materials with certain properties are covered. The components made from these control materials, how they are fabricated, and how they are used in nuclear reactors are described. (M.C.G.)

23289 EXPERIMENTAL LOOP USED IN THE RA-1 REACTOR. A. Blumenkrantz (Comisión Nacional de Energía Atomica, Buenos Aires). IAEA Preprint CN-13/3. 18p. (In Spanish)

To be published in the Proceedings of the IAEA Conference on the Corrosion of Reactor Materials held in Salzburg, 4-9 June 1962.

An experimental circuit is described for the study and detection of breaks in fuel element cladding. The circuit includes an in-pile device, reproducing the thermal conditions of the RA-1 reactor (water at atmospheric pressure, 50°C, velocity 5 cm/sec), by means of which corrosion induced inside the experimental reactor under the existing conditions of irradiation can be analyzed. The method used for detecting fission products is continuous physico-chemical separation of anions and selective detection of gamma rays emitted within a certain energy band. For this purpose the circuit includes, at the outlet of the irradiation device, two ion exchange resin vessels arranged in a cascade. The fuel elements studies are of the RA-1 type: extruded bars of disperse U_3O_8 in an aluminium matrix, with aluminium cladding. With this device, a study was made of elements of natural uranium and uranium enriched to 20%, with the cladding deliberately damaged to see what would happen to stability under simultaneous corrosion and irradiation, extent and mechanism of fission product release, and distribution of activities in the various parts of the circuit. Uranium entrainment was measured from deposition of uranium in the circuit filter. Simultaneous radiochemical measurements were made of coolant activity and of specific fission products contained in the coolant. An effort is also being made to determine the escape coefficient (probability per unit time of a particular isotope escaping from the fuel element). (auth)

23290 THE BEHAVIOR OF CORROSION PRODUCTS IN BOILING WATER REACTORS. F. J. Brutschy, R. S. Gilbert, and R. N. Osborne (General Electric Co., Pleasanton, Calif.). IAEA Preprint CN-13/17. 36p. (In English)

To be published in the Proceedings of the IAEA Conference on the Corrosion of Reactor Materials held in Salzburg, 4-9 June 1962.

The corrosion products in the coolant of a large boiling water reactor were studied both chemically and radiochemically to determine their sources and composition. The results obtained from the Dresden plant are presented and compared to similar measurements that are available from other water-cooled reactors. Comparisons of circulating and deposited material as well as observations on

changes in the specific activities of important nuclides are used to provide information on the rates of activation and exchange occurring in the system. The corrosion of in-core and out-of-core surfaces is compared to establish the relative contribution of each to the material and activity in the coolant, so that the radiochemical importance of certain elements present in low concentrations can be recognized. Experiments in the Vallecitos Boiling Water Reactor are also described that show the importance to radiochemistry of controlling the composition and corrosion rates of all of the components in the reactor system. Radiochemical methods provide a sensitive measure of the presence of corrosion products in the coolant as well as an indication of their importance to the actual operating reactor. The methods used to control corrosion product levels in the coolant are considered and compared to the calculated corrosion rates of the materials in the system. The relative competition between clean-up and deposition in water-cooled reactors indicates that the influence of undesirable corrosion products can be seen even after their source has been removed. The need for adequate chemical surveillance as part of the operating program of a reactor is discussed together with an outline of the methods found to be useful and indicative in the reactors studied to date. (auth)

23291 OPERATING NUCLEAR REACTORS SAFELY. G. C. Laurence (Atomic Energy Control Board, Ottawa). IAEA Preprint SM-24/8. 10p.

To be published in the Proceedings of the IAEA Symposium on Reactor Safety and Hazards Evaluation Techniques held in Vienna, 14-18 May 1962.

The safety of a reactor depends not only on its design. It depends also on how the reactor is operated and maintained. To retain a high standard of safe operation, it is necessary to state what the required standard is and to determine whether the performance matches that standard. This calls for (1) specification of the number of dangerous faults of various kinds that may be permitted in the process equipment and in the regulating system in a specified time interval such as ten years, (2) observation or testing to detect dangerous faults, (3) changes in equipment or in procedure if faults are occurring so frequently that the permissible number in the specified time interval is liable to be exceeded. It also calls for (4) specification of permissible frequency of dangerous operating mistakes, (5) observation of their occurrence, and (6) changes in equipment or procedure to reduce the causes if the permissible limits are liable to be exceeded. In the protective system and in the containment provisions safe operation calls for (7) specification of the maximum permissible unreliability, i.e. the fraction of time the system or provision is incapable of performing its intended function, (8) observation and testing to detect dangerous faults, to determine their duration and to deduce the unreliability of the system or provision, and (9) changes in the equipment, the operating procedures or the frequency of testing and maintenance practice in order to fulfill the requirement of low unreliability. The paper discusses how the maximum acceptable frequency of dangerous faults in the process equipment or in the regulating system is decided, and how relevant experience from other sources may be used in estimating the expected upper limit of frequency of dangerous faults and mistakes. It describes how the acceptable maximum limits of unreliability for the protective devices and for the containment provisions are chosen and how the performance of the plant is compared with these limits. (auth)

23292 PAST AND PRESENT TRENDS IN REACTOR SAFETY PROCEDURES. G. A. Tingate (Australian Atomic Energy Commission Research Establishment, Sutherland). IAEA Preprint SM-24/21. 33p. (In English)

To be published in the Proceedings of the IAEA Symposium on Reactor Safety and Hazards Evaluation Techniques held in Vienna, 14-18 May 1962.

The Australian Atomic Energy Commission's high-flux materials testing reactor HIFAR has been operating at full power for two years. The safety aspects of the reactor itself, and of the irradiation rigs associated with it, have been subject to continual appraisal and review for some six years, and a good measure of finality has now been achieved. HIFAR was the first reactor to be commissioned in Australia, consequently some staff members had had no previous experience or training in this type of work. Safety matters were therefore given very detailed consideration, and very elaborate documentation, including safety assessments, were prepared and approved before various changes and operations were authorized. Such matters were dealt with initially on an ad hoc rather than a systematic basis, and this combined with the policy of always introducing safety measures when in doubt inevitably led to expensive and time-consuming measures which were subsequently proved in service to be superfluous. As operating experience accumulated, the staff became more conversant with reactor safety problems and requirements, and many hazards were found to be less important than originally feared. It was therefore possible to simplify or eliminate a number of protective measures, while maintaining the stipulated standard of safety. Recommended standards and criteria for safety are given, and a systematic method of evaluating hazards and stipulating and maintaining protective measures is described. Some examples are given of protective measures which have been proved superfluous in service, together with a brief description of the methods used to prove this. (auth)

23293 COMBUSTION IN AIR OF MAGNESIUM-CLAD FUEL ELEMENTS. D. Martin, J. Bauzit, and R. Cante (Centre de Production du Plutonium, Marcoule, France). IAEA Preprint SM-24/31. 19p. (In French)

To be published in the Proceedings of the IAEA Symposium on Reactor Safety and Hazards Evaluation Techniques held in Vienna, 14-18 May 1962.

In a reactor of intermediate specific power, air-cooled at atmospheric pressure, combustion of an element owing to accidental and local absence of cooling is a possible incident. An accident of this type took place in G1 in October 1956, and the recent analysis of the remnants of the destroyed element has yielded some additional information; more particularly, it is now possible to establish a relationship between the relative extent of the accident in the channel and the slight effects recorded outside. Significant photographs show the deterioration of the rods and prove that the melting point was exceeded along a certain length; along the remainder of the element, the cladding is found to have burned completely while attacking the uranium only superficially. In addition, laboratory tests were conducted in a small experimental channel on portions of magnesium-clad elements. These tests permitted exact determination of the ignition temperatures and of the conditions under which combustion of sheathing and uranium can occur in air under various blower conditions. (auth)

23294 INTRINSIC REACTOR SAFETY THROUGH DESIGN. N. J. Palladino and A. H. Foderaro (Pennsylvania State Univ., University Park). IAEA Preprint SM-24/36. 73p. (In English)

To be published in the Proceedings of the IAEA Symposium on Reactor Safety and Hazards Evaluation Techniques held in Vienna, 14-18 May 1962.

The safety characteristics of a reactor system which can be strongly influenced by design may be classified under two headings, those that are inherent to the core and those inherent to the control system. As examples of the first are the temperature and or power coefficients, flow coefficients, or pressure coefficients influencing nuclear characteristics; heat capacity and conductivity of the fuel elements and cladding influencing meltdown-characteristics during transients; incorporation of built-in fuses, or other devices to implement shutdown. As examples of the second are interlocks, redundancy and duplication of components in control systems, and multiple safety settings for scram points. Permeating the design philosophy may be the concept of large margins of safety at crucial points insofar as these margins can be identified as contributing to the safety without negating the purpose of the reactor. A discussion is given of the type of stpps which one can take at present, the steps currently being taken and steps that might be taken with further research and development work in prescribed areas, to enhance safety by means of design. (auth)

23295 REACTIVITY CONSIDERATIONS IN REACTOR SAFETY ASSESSMENTS AT A.E.R.E., HARWELL. W. B. Woollen (Atomic Energy Research Establishment, Harwell, Berks, Eng.). IAEA Preprint SM-24/47. 11p.

To be published in the Proceedings of the IAEA Symposium on Reactor Safety and Hazards Evaluation Techniques held in Vienna, 14-18 May 1962.

Since 1948, four high power research reactors, Bepo, Dido, Pluto and Lido, and seven low power or zero energy reactors, Gleep, Nero, Neptune, Zephyr, Zeus, Dimple and more recently Daphne, have been through a detailed and formal safety clearance procedure. Some of the more interesting points which have received detail scrutiny by the working parties are discussed, in particular those concerning Bepo, Dido and Daphne. (auth)

23296 THE IMPLICATIONS OF AUTOMATION AND OF NEW TECHNIQUES FOR THE ENHANCEMENT OF SAFETY IN NUCLEAR REACTOR CONTROL. J. Furet (Centre d'Études Nucléaires, Saclay, France). IAEA Preprint SM-24/55. 20p. (In French)

To be published in the Proceedings of the IAEA Symposium on Reactor Safety and Hazards Evaluation Techniques held in Vienna, 14-18 May 1962.

The digitizing of nuclear reactor control permits the use of new electronic techniques, the main advantages of which are greater operational safety, greater centralization, and maximum possible elimination of linear elements. Moreover, arrangements of the digital type generally appear better suited to the logic of automation systems and safety sequences. At the present time, these digital techniques appear to be particularly important and advantageous in the control of power reactors and high-flux experimental reactors, where the development of automation is a necessity from the point of view of safety. Generally speaking, three types of automation may be distinguished. (1) regulatory automation systems, which improve both operational safety and yield; (2) sequential automation systems, which increase functional safety and prevent mistakes; (3) information processing as a whole, most frequently in conjunction with the two preceding types of automation. In particular, the implications of sequential automation systems for operational safety are discussed, since it is such systems which permit fully automatic operation of the installation as a whole even during such transient states as starting, stopping or incidents. The value, from the point of view of safety, of using numerical computers, especially for the calculation of poisoning, reactivity, flux, etc., is shown. Some examples of automation systems, either planned or already completed, which use the new electronic techniques in the control of nuclear reactors are given. (auth)

23297 DESIGN AND OPERATION OF A REACTOR SAFETY SYSTEM. K. Becker (Kernreaktor Bau- und Betriebsgesellschaft, Karlsruhe, Ger.). IAEA Preprint SM-24/60. 18p. (In English)

To be published in the Proceedings of the IAEA Symposium on Reactor Safety and Hazards Evaluation Techniques held in Vienna, 14-18 May 1962.

A reactor safety system has to be designed not only for guaranteeing a high grade of safety but also for minimizing false scrams caused by instrument failures. It is shown by results of probability calculation that a 2 out of 3 system gives good results in this respect. For satisfactory performance of the system, it is very important that the 2 out of 3 selecting idea is followed throughout the whole system; there must not be one link of central importance that could reduce the grade of safety or increase the probability of a false scram. At the FR 2 in Karlsruhe it is attempted to get a system of that nature. Experience shows that a good amount of labor has to be invested to come to this result. In 9 channels, each having 3 separate tracks, neutron flux, reactor period, coolant temperature and flow, and activity in the reactor building and at the stack exit are surveyed. Special Comparison Units again reduce the probability of a false scram; they continuously compare the instrument signals of each channel in the 3 tracks. A faulty track is turned off and the remaining 2 tracks of the channel continue working in a 1 out of 2 system. This operation is without any influence on the other channels. There is one common 2 out of 3 unit for all channels with the 2 out of 3 selecting system continued as far as to the magnet circuits of every shim rod. Since the FR 2 has been in operation for the zero power experiments since March 1961 with the whole safety system, there is some experience how the system works. For more than 7 months there has been no scram caused by instrument failures, though there has been considerable amount of these failures. There have been scrams due to some details in the circuitry which were not planned consequently enough; some examples are given. A facility to check the complete safety tracks during reactor operation has proved to be very useful. (auth)

23298 ACTIVITIES OF THE GERMAN TECHNISCHE UBERWACHUNGS-VEREINE (TECHNICAL SUPERVISION ASSOCIATIONS) RELATING TO THE SAFETY OF REACTOR STATIONS. G. Wiesenack (Technische Uberwachungs-Vereine, Essen, Ger.). IAEA Preprint SM-24/68. 12p. (In English)

To be published in the Proceedings of the IAEA Symposium on Reactor Safety and Hazards Evaluation Techniques held in Vienna, 14-18 May 1962.

According to the "Bundesatomgesetz" (Federal Atomic Act), in the Federal Republic of Germany and in West Berlin, the Länder are charged by order of the Federal Government with the execution of license procedures relating to nuclear plants. To accomplish these tasks, the competent authorities may consult experts. Thus, they have repeatedly availed themselves of the Technische Uberwachungs-Vereine (TUV, Technical Supervision Associations), who since decades are charged by the Government with the inspection and supervision of such installations in all fields of technics, which are in need of such supervision. The range and extent of the TUV's activities is then described. The TUV's are united in the Vereinigung der Technischen Uberwachungs-Vereine (VdTUV) (Union of Technical Supervision Associations) with site at Essen/Ruhr. A further

discussion refers to the co-operation of the Arbeitsgruppe für Reaktorsicherheit (Working Committee on Reactor Safety), which had been promoted by the VdTUV, with the Reaktorsicherheitskommission (Reactor Safety Commission) established by the Federal Ministry on Atomic Energy, and also the competent local TUV. (auth)

23299 REVIEW OF REACTOR NUCLEAR INCIDENTS. H. B. Smets (European Nuclear Energy Agency, Paris). IAEA Preprint SM-24/79. 46p. (In English)

To be published in the Proceedings of the IAEA Symposium on Reactor Safety and Hazards Evaluation Techniques held in Vienna, 14-18 May 1962.

An over-all survey is presented of about seventy nuclear incidents which occurred in connection with the operation of nuclear reactors and critical assemblies. When applicable, the following information is given: (a) location and data of the incident; (b) nature of the incident; (c) number of persons involved and extent of exposure; (d) financial losses. The reactor nuclear incidents are divided in the following six categories: 1. Criticality incidents and power excursions; 2. Fuel element failures; 3. Corrosion in the reactor vessel and in the primary circuit; 4. Contamination due to lack of containment of the coolant; 5. Contamination of the reactor or reactor hall by experimental equipment; 6. Reactor operators' external radiation incidents. (auth)

23300 A REVIEW OF BOILING REACTOR SAFETY. J. A. Thie (McLain Rodger Associates, Downers Grove, Ill.). IAEA Preprint SM-24/80. 21p. (In English)

To be published in the Proceedings of the IAEA Symposium on Reactor Safety and Hazards Evaluation Techniques held in Vienna, 14-18 May 1962.

After a decade of experience in boiling reactor design, experimentation, and operation, much has been learned about the safety aspects of this reactor type. The kinds and sources of safety information obtained in the experimental programs of a dozen reactors operated in the USA are summarized. Hazards associated directly with the core may be divided into spontaneous and induced categories. Of principal interest in the former are stability problems. From a variety of experiments it has been shown that unstable tendencies may be due to: direct positive feedback of delayed steam void reactivities; basically hydraulic phenomena; interactions of the reactor and external equipment. Certain significant parameters—amplitudes, frequencies, and time constants—have been experimentally determined as concisely characterizing unstable tendencies, and these data from many reactors are summarized. A theoretical understanding of these experiments has also been achieved. Design criteria and methods of avoiding unstable tendencies are presented. Hazards also exist which may be induced by coolant and reactivity transients. These are enumerated together with design considerations they necessitate. Special problems are met when a boiling core is used in conjunction with a superheater, whether integral or external. Other design problems arise out of conflicts between safety requirements and economic optimum performance. In particular, it is shown how postulated hazards influence the design of fuel elements and the control system. Many methods of obtaining quantitative measures of boiling reactor safety are evaluated. Reactivity coefficients, void volumes, and other parameters influencing dynamic behavior have been measured on the one hand, while integral dynamics experiments on the other hand give their combined effect. Of special interest has been the development of general techniques of obtaining information about reactors without necessitating complex experimental equipment and interfering with reactor operation: spectral density in the frequency domain of the reactor power and other functions; cross-correlation of reactor functions; fundamental time constants and frequency constants by elementary analyses of fluctuations in the time domain. Related to these experiments, the theory of the effect on safety, of stochastic processes present in boiling reactors is discussed. (auth)

23301 LIFTING DEVICES. Norman Bradley and Jack Jones (to United Kingdom Atomic Energy Authority). U. S. Patent 3,039,811. June 19, 1962.

A piston-operated grab is designed for retrieving articles from vertical channels of a reactor cooled with vapor, e.g., steam. The volume enclosed by the piston and its cylinder is connectable to evacuating means and communicates with ambient pressure via a bleed valve or orifice. The grab is provided with remotely disposed indicating means. (D.L.C.)

23302 FLUIDIZED BED NUCLEAR REACTOR. Charles M. Slack, Walter G. Roman, Sidney Krasik, and William J. Purcell (to Westinghouse Electric Corp.). U. S. Patent 3,039,945. June 19, 1962.

A reactor using fuel pellets fluidized by coolant flow is designed so that it may be used to breed new fuel materials, to irradiate materials, and to produce radioisotopes. The reactor has a tubular partition enclosing the pellet fuel bed which may be filled with pellets or fertile material or with reflector pellets. The reactor also has means for introducing and removing pellets from various zones of the fuel bed; the pellets are made of different densities or masses, and conduits are provided for removing pellets from different zones of the bed. (D.L.C.)

23303 ADJUSTMENT SYSTEM FOR FLUID FUEL NUCLEAR REACTORS. Cecil B. Ellis (to Foster Wheeler Corp.). U. S. Patent 3,039,946. June 19, 1962.

A system is designed for safely supplying amounts of fuel or additives to a fluid fuel reactor. The system has a conduit between a liquid reservior and the reactor, and a plurality of valves with surge tanks are provided in the conduit to supply regulated amounts of liquid to the reactor in a slug-like fashion. A locking bar system is provided to prevent operation of a valve until the other valves are closed. (D.L.C.)

23304 FUEL ELEMENTS FOR NUCLEAR REACTORS. Peter Fortescue and George Edward Lockett (to United Kingdom Atomic Energy Authority). U. S. Patent 3,039,947. June 19, 1962.

A core element is designed for high-temperature gas-cooled reactors. The core element comprises an impermeable tubular graphite container, a graphite rod located axially in the container by means of flanges, and graphite sleeves loosely stacked in each annular recess defined between adjacent pairs of flanges, the sleeves also containing small amounts of fissile and fertile material. (D.L.C.)

23305 FUEL ELEMENT HANDLING APPARATUS. Albert E. Newton and George K. Richardson (to United Shoe Machinery Corp.). U. S. Patent 3,039,949. June 19, 1962.

A fuel element extraction tool is designed for use with a fuel handling apparatus above a reactor. The tool has a load supporting means with strain measuring devices for sensing the direction and magnitude of the load imposed on the tool. (D.L.C.)

23306 METHOD OF REMOVING GASEOUS FISSION PRODUCTS FROM GASES. Ivan F. Weeks (to North American Aviation, Inc.). U. S. Patent 3,041,134. June 26, 1962.

A method is given for isolating fission gases and oxygen in a radioactive gas circulating through a closed-cycle water boiler reactor using solutions of uranyl nitrate or sulfate. When the radioactivity of the circulating oxygen carrier reaches a predetermined value, the carrier is passed through a filter and a choked flow orifice into a reaction chamber containing powdered P, Li, Ca, Mg, or H_2 to form oxides thereof. The sonic flow condition prevents the reaction from becoming violent, and the remaining fission gases may be stored in a small volume. (D.L.C.)

23307 REACTOR FUEL ELEMENT. Wayne H. Jens (to United Nuclear Corp.). U. S. Patent 3,041,262. June 26, 1962.

A reactor fuel element for a power reactor using a fluid both as coolant and as working fluid is designed for efficient heat transfer and for containment of fission products. The fuel element comprises a central core of fissionable material surrounded by a cladding tube and a jacket provided with hollow protuberant spines. Spaces are provided between the core, the cladding tube, and the jacket which are filled with a fluid of high thermal conductivity, e.g., a metal. (D.L.C.)

23308 BOILING WATER ATOMIC REACTOR. Pierre-Jean Ricard (to Commissariat a l'Energie Atomique). U. S. Patent 3,041,264. June 26, 1962.

A boiling reactor is designed with a barrier cylinder for controlling the evacuation of water and the natural circulation and for reducing the influence of reactor inclination and water turbulence such as that produced by roll of a ship. The cylinder is disposed around the stacks at the top of the core to form a barrier between the water evacuated by the cyclones and the water of the reflector. Thus, the water level in the central part of the reactor is kept higher than that in the peripheral reflector. (D.L.C.)

Power Reactors

23309 (ACNP-62010) STRESS AND DEFLECTION OF BOILER FUEL ELEMENT BOXES. Lloyd E. Vlies (Allis Chalmers Mfg. Co. Atomic Energy Div., Milwaukee). Apr. 13, 1962. For Northern States Power Co., Minneapolis and Central Utilities Atomic Power Associates. Contract AT(11-1)-589. 48p.

Equations were derived by strain-energy methods for analyzing the stress and deflection in the boiler fuel element boxes used in the Pathfinder nuclear reactor. These boxes are of two types, both constructed of Zircaloy II. One box is approximately 5 in. sq. The second is approximately 10⅛ in. sq divided internally into four compartments (5 in. sq) by a cruciform control-rod guide structure. Stress and deflection in the box walls are caused by pressure differences across the walls. The equations were verified by testing an aluminum model of the single-element box and a Plexiglas model of the four-element box. There was less than 10% difference between theoretical and measured values for the maximum stress and deflection, and therefore, use of the equations for designing the Pathfinder fuel element boxes is justified. (auth)

23310 (APAE-35(Suppl.3)) SM-1 SHIELDING ANALYSES. L. D. Stephenson (Alco Products, Inc., Schenectady, N. Y.). June 20, 1962. Contract AT(30-1)-2639. 28p.

Gamma dose rate and neutron measurements were analyzed in their relation to the SM-1 shield design and is a continuation of previous shielding measurements and analyses. The data reported are spent fuel element and rod drive pit gamma dose rates. An analysis of gamma dose rates off the core mid-plane is presented and compared with test data. (auth)

23311 (APAE-113) ARMY PWR SUPPORT AND DEVELOPMENT PROGRAM SIX MONTHS SUMMARY REPORT, OCTOBER 1, 1961–MARCH 31, 1962. (Alco Products, Inc., Schenectady, N. Y.). May 25, 1962. Contract AT(30-1)-2639. 206p.

Progress is reported on research and development tasks on the Army Pressurized Water Reactor Power Plants. Topics covered include: engineering services, performance of existing cores, replacement core development, primary system performance, primary system activity control, radiation damage in reactor pressure vessels, secondary system performance, radioactive waste control, nuclear power instrumentation, replacement core procurement, and integrated test programs for SM-1, SM-1A, and PM-2A. (M.C.G.)

23312 (APAE-Memo-304) STRESS ANALYSIS OF THE PM-2A REACTOR VESSEL. B. J. Rowekamp, D. W. McLaughlin, R. A. Chittum, and C. C. Aitken (Alco Products, Inc., Schenectady, N. Y.). May 14, 1962. Contract AT(30-1)-2639. 158p.

The stress analysis performed on the PM-2A reactor vessel and cover is discussed. The maximum combined stress (51,000 psi) occurred in the studs after reaching steady-state conditions. A fatigue analysis indicated that this stress could be safely applied 2500 times, and since the studs do not approach 2500 cycles from initial stud tightening to steady-state conditions, they should not suffer any fatigue damage. (auth)

23313 (APEX-366) NUCLEAR ANALYSIS OF HTRE NO. 2 WITH HYDRIDED ZIRCONIUM MODERATOR INSERT. C. Cyl-Champlin and J. M. Krase (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Aug. 1956. Contracts AF33(038)-21102 and AT(11-1)-171. 46p.

The nuclear design of HTRE No. 2 with a hydrided zirconium moderated insert was completed. Nuclear feasibility was established. The HTRE No. 2 reactor is basically the HTRE No. 1 core with the center seven cells replaced with an aluminum-walled hexagonal cylindrical opening for the introduction of test inserts. The HTRE No. 1 power plant consists of an air-cooled, metallic-fuel-element, water-moderated reactor operating a single modified J47 turbojet engine. It is recommended that for maximum reactivity of HTRE No. 2, an 8-inch beryllium reflector be incorporated into the design. Also, from the aspect of power flattening and reactivity it is recommended that "excess" water around the well be replaced by beryllium. (auth)

23314 (DC-55-7-71) AIRCRAFT REACTOR CONTROL SYSTEM APPLICABLE TO TURBOJET AND TURBOPROP POWER PLANTS. G. E. Gorker (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). July 19, 1955. Contract [AT(11-1)-171]. 14p.

Control systems proposed for direct cycle nuclear powered aircraft commonly involve control of engine speed, nuclear energy input, and chemical energy input. A system in which these parameters are controlled by controlling the total energy input, the ratio of nuclear and chemical energy input, and the engine speed is proposed. The system is equally applicable to turbojet or turboprop applications. (auth)

23315 (DLCS-3430103(Rev.)) PERIODIC CALIBRATION OF LEVEL INSTRUMENTATION. CORE I, SEED 3. Test Evaluation. (Duquesne Light Co., Shippingport, Penna.). First issue, Jan. 29, 1962. Second issue, Apr. 30, 1962. Contract [AT(11-1)-292]. 54p.

Tests were carried out to determine and correct any calibration drift in water level instrumentation and to scale

the Data Acquisition System for the pressurizer level instrumentation. All the level instrumentation, except that associated with the pressurizer, was calibrated to the required accuracy. The pressurizer level instrumentation was calibrated to the specified accuracy over the normal operating range. (M.C.G.)

23316 (DLCS-4000301) AUTOMATIC DATA LOGGING AND COMPUTING SYSTEM CALIBRATION TEST. Section 3. (Duquesne Light Co., Shippingport, Penna.). [nd]. 84p.

The automatic data logging and computing system was set up to record station operating parameters, and a calibration curve was obtained for the instrument trains as read on the computer. Noise and non-linearity caused the greatest deviations seen by the data acquisition system. Although some parameters did not meet specifications from 0 to 100%, they did meet the requirements throughout their normal operating ranges. (M.C.G.)

23317 (DLCS-5000462) MONTHLY OPERATING REPORT, APRIL 1962. (Duquesne Light Co., Shippingport, Penna.). Contract AT(11-1)-292. 49p.

The significant operations, occurrences, and other station activities are reported. Operation, station performance, incidence, chemistry, health physics, maintenance, test program, training, and construction and major modifications are discussed. (M.C.G.)

23318 (MND-M3A-2450) PM-3A NUCLEAR POWER PLANT PROGRAM. Third Quarterly Progress Report, February 16, 1961 to May 15, 1961. (Martin Co. Nuclear Div., Baltimore). July 21, 1961. Contract AT(30-1)-2700. 50p.

A summary of the PM-3A nuclear power plant design is presented. Plant design and liaison, core fabrication and testing, plant procurement and component fabrication, plant assembly, and training and project services are described. (M.C.G.)

23319 (MND-P-3018-I) SNAP RADIOISOTOPE SPACE PROGRAMS QUARTERLY PROGRESS REPORT NO. 10, TASK 7, JANUARY 1 THROUGH MARCH 31, 1962. (Martin Co. Nuclear Div., Baltimore). Contract AT(30-3)-217. 21p.

In the absence of reduced test data from the upper atmosphere re-entry study for the comparative analysis of actual test results and predicted results, effort was expended in review of raw data to recover information not previously uncovered. A review of the K-24 film disclosed that its reading with a densitometer could prove beneficial; in addition, the mechanical errors responsible for the poor quality of data recorded were revealed in sufficient time for corrective measures to be taken for any subsequent testing. Review of spectral photographs disclosed faint second-order characteristic lines which, possibly, will permit identification of the test specimens by the flare materials they contained. The telemetry canister was redesigned to accommodate an operational antenna on the test; modification of the canister was initiated. An analysis of code-calculated dose rates from the Sr^{90} weather station generator resulted in better correlation than previously achieved. A doubling technique wherein unabsorbed particles were split after traveling at least three mean free paths was incorporated into the code for these runs. (auth)

23320 (NDA-14-155) NEUTRON PENETRATION THROUGH THE SIDE SHIELD OF THE APDA REACTOR. Phillip S. Mittelman (Nuclear Development Corp. of America, White Plains, N. Y.). Dec. 20, 1956. 18p.

The fast neutron leakage from the side shield of the APDA reactor was estimated using more refined calculational techniques than those employed in earlier studies. The results of this calculation indicate that the fast neutron leakage from the graphite of the side shield is considerably lower than previously estimated; while the low energy leakage is higher than previously estimated. The fast leakage is 7×10^6 n/cm^2-sec compared to Yamauchi's estimate of 2.3×10^8. The low energy leakage is $\sim 7 \times 10^8$ n/cm^2-sec as compared to Yamauchi's value of 3×10^8 n/cm^2-sec. The reactor power is assumed to be 500 Mw. (auth)

23321 (NMI-7248) POWER REACTOR PROGRAM. Progress Report to Savannah River Operations Office, United States Atomic Energy Commission for the Period February 1 through February 28, 1962. S. Isserow, R. W. Anderson, A. B. Bremer, and W. L. Larson (Nuclear Metals, Inc., Concord, Mass.). May 10, 1962. Contract [AT(30-1)-1565]. 26p.

Preliminary to fabrication of a set of enriched inner tubes for the HWCTR, a prototype tube was extruded for evaluation of a modified billet design and of cladding components. Detailed evaluation of 9 brazed end closures prepared by the most promising procedures showed that at least the lowermost 0.18-in. of the seal is void-free if the radial clearance between the plug and inside cladding is no greater than about 0.007-in. As a result of brazing HWCTR tube sections, the uranium core and the cladding-core interface are affected to about 2-in. from the end of the uranium core. In this zone the uranium grains are somewhat coarser after beta treatment and the core-cladding bonds, while still adequate, appeared to have deteriorated to some extent. Metallographic and hot hardness studies conducted on tubes of unalloyed uranium, U–0.08 wt % Si, and U–0.05 wt % Cr–0.10 wt % Mo showed that each composition has instabilities after beta treatment. Both alloys in the conditions tested were consistently harder to 600°C than the unalloyed uranium. (auth)

23322 (NP-11823) ANALISI DEL CICLO U–Th IN UN REATTORE AD ACQUA BOLLENTE. (Analysis of U–Th Cycle in a Boiling Water Reactor). V. Benzi, P. Loizzo, and G. Solinas (Italy. Comitato Nazionale per l'Energia Nucleare, Rome). May 1962. 27p.

The U–Th fuel cycle in a boiling water reactor is studied, using the Westcott model for cross sections and the zero-dimensional scheme for reactor-lifetime calculations. This problem is here reconsidered using new values for some physical and economical data (including FP cross sections, Th resonance integral, etc.). These new data strongly affect the reactor operation characteristics. Nevertheless, although the reactor is not optimized for the use of Th as a fertile material, the good economy of the U-Th cycle, with respect to U-Pu cycle, is confirmed for this type of reactor. (auth)

23323 (TID-15438) MONTHLY OPERATING REPORT [ON SHIPPINGPORT REACTOR] DECEMBER 1961. Vol. IV– Issue 12. (Duquesne Light Co., Shippingport, Penna.). Contract AT(11-1)-292. 42p.

The operation of the Shippingport Pressurized Water Reactor is summarized. Topics covered include: summary of operations, station performance, incidents, chemistry, health physics, maintenance, test program, training program, and construction and major modification. (M.C.G.)

23324 THE SELNI ATOMIC POWER PLANT, DEDICATED TO ENRICO FERMI. PROGRESS OF PROJECT AND CONSTRUCTION OF MACHINERY. Quaderni studi e notiz. (Milan), 17: 14-18(Jan. 1961). (In Italian)

A brief history is given of the design and development of the SELNI nuclear power plant as an introduction to a description of the present state of progress. Some of the technical problems faced and the solutions developed are

discussed. The present state of construction of the turbines, alternator, and core devices is reviewed. (J.S.R.)

23325 THE ROWE NUCLEAR POWER PLANT OF THE YANKEE ATOMIC ELECTRIC COMPANY. SOME FIRST OPERATING EXPERIENCES IN THE RUNNING-IN PHASE. Quaderni studi e notiz. (Milan), 17: 128-32(Feb. 1961). (In Italian)

The principle characteristics of the Rowe Nuclear Power Plant are briefly reviewed as an introduction to a discussion of the preliminary results of the running-in operation. The phases discussed are preliminary testing of the primary system and its auxiliaries, the fuel charge, low-power testing, running-in tests on the turbine, and measurements at various power levels. The principle operations during each phase and the results obtained are discussed individually. (J.S.R.)

23326 SISTEMY UPRAVLENIYA I KONTROLYA YADERNYKH REAKTOROV ATOMNYKH ELEKTROSTANTSII. (Control Systems and Control of Nuclear Power Plants). A. F. Popov. Moscow, State Publishing House of Power Literature, 1961. 216p.

Engineering problems of measurement, reactor power modulation, and emergency safety measures are discussed in the first three chapters; the fourth deals with the technology of control systems. Practical data are offered for selecting elements, systems, and instruments for graphite and water moderated reactors. The book is designed for technical personnel and engineers working in nuclear power plants. (R.V.J.)

23327 NUCLEAR PROPULSION FOR MERCHANT SHIPS. A. W. Kramer (Division of Technical Information, AEC). 1962. 609p. $2.25(GPO).

Information acquired by the nuclear ship program in the United States is summarized. Topics covered include: reasons for nuclear propulsion, the commercial nuclear ship program in the United States, basic principles of nuclear reactors, the N.S. Savannah, hazards analysis, operating and environmental considerations, servicing nuclear ships, training of the N.S. Savannah crew, international aspects of nuclear ship propulsion, suitability of different reactor types, economics of nuclear propulsion, nuclear tanker design, and world nuclear ship development. (M.C.G.)

23328 EARTHQUAKE RESISTANT DESIGN FOR NUCLEAR PLANTS IN JAPAN. K. Takeyama et al. (Ministry of International Trade and Industry, Tokyo). IAEA Preprint SM-24/27. 19p.

To be published in the Proceedings of the IAEA Symposium on Reactor Safety and Hazards Evaluation Techniques held in Vienna, 14-18 May 1962.

A regulation published in February 1961 is intended to apply to light water or gas cooled type reactor power plants which will be constructed in Japan. A part of the regulation is concerned with earthquake resistant design. The fundamental principle and objects taken in the regulation are described. The fundamental principle is to make protection for adjoining inhabitants and operators from accident due to earthquake. The objects are civil and mechanical structures, facilities, equipments and pipings in plants, and they are classified into three classes, or A, B and C, in accordance with degrees of their properties for radiation hazard. Collections of past disastrous records of earthquake at site and reliable foundations of structures are required. Specific considerations for structural design of civil structures are required. Static seismic forces for structures of A, B and C-classes are specified respectively. Furthermore, in regard to A-class structures dynamic analysis is required, and evaluation of the most strong credible earthquake which is used in dynamic analysis is specified. Allowable stress and stress combination are mentioned. The dynamic analyses about the mechanical structures, facilities, and equipments are required, and two methods for classification of them into A, B and C-classes and into rigid, intermediate and flexible components from dynamic consideration are mentioned. In stress analysis, considerations about allowable stress, repeated stress and stress combination as well as radiation effect of materials are required. Limitation of deformation due to vibration is specified. The dynamic analysis for the piping lines is required. Two independent safety protection systems, including seismic detectors, against earthquake are required. Present values of the detectors are specified. Vibration tests, in order to make sure the safety, are required upon complicated or uncertain components after their construction. (auth)

23329 ENGINEERING DEVELOPMENT OF CALDER-TYPE POWER REACTORS ARISING FROM FAULT ANALYSIS. G. R. Bainbridge and L. J. Goudy (United Kingdom Atomic Energy Authority, Risley, Eng.). IAEA Preprint SM-24/53. 27p. (In English)

To be published in the Proceedings of the IAEA Symposium on Reactor Safety and Hazards Evaluation Techniques held in Vienna, 14-18 May 1962.

A wide range of possible, though in some cases extremely unlikely, fault conditions was studied for each of the Calder-type power reactors being brought into operation in Britain, Italy, and Japan. The predicted transient core temperatures, which reveal how well the integrity of the fuel cans would be retained after a fault, were found to be very dependent on the values used for data and the detailed assumptions made with regard to the plant conditions. Examination of the broad effect on transient temperatures caused by postulated changes in items of data and assumptions led to a concentration of experimental effort aimed at narrowing the range of uncertainty in the more important data and to plant improvements achieved at relatively little cost. An outline is given of the more severe plant faults studied, namely reactivity changes in excess of those planned, for start-up and the reactor at power, failure of all blowers, and loss of coolant. The nature is discussed of the engineering modifications found practical; these include improvements in core, control rod, pressure circuit, and biological shield arrangements. (auth)

23330 POWER REACTIVITY COEFFICIENTS AND SAFETY PROBLEMS OF REACTORS. N. V. Krasnoyarov. IAEA Preprint SM-24/81. 14p. (In Russian)

To be published in the proceedings of IAEA Symposium on Reactor Safety and Hazards Evaluation Techniques held in Vienna, 14-18 May 1962.

Various steps in fast reactor reactivity power effects and safety are analyzed. Various methods used in the investigation of BR-5 reactor operations are discussed, and the results of one of the methods are given. Measurements showed that the roles of various power-effect components change after burnup, leaving a small positive reactivity coefficient. A reliable negative reactivity power coefficient is anticipated in large fast reactors. (R.V.J.)

Production Reactors

23331 PHYSICS OF BREEDERS. Krystyna Kowalska. Postępy Tech. Jądrowej, No. 4, 559-82(1961). (PAEC-RR-4) (In Polish)

The term breeder reactor is restricted to the type wherein the produced fissionable material is chemically

and isotopically identical to the reactor fuel. Where the two are not identical, the reactor is called a converter reactor. In this article, the second of a series on breeder reactors, the introductory remarks include a discussion of the probable future power requirements of the world and the power available from deuterium, Li^6, uranium, and thorium. The treatment of breeder reactors that follows deals only with fission reactors. They are broken down into three types; fast breeders, slow breeders, and combination fast-slow breeders. The critical mass of the fissionable materials is given as a function of percentage fissionable material intermixed with the breeder material, as a function of impurities as contained in structural material and coolant, and as a function of geometry of the fuel-moderator-coolant combination. The initial coefficient of breeding, the reactivity as a function of duration of burning cycle, the temperature coefficient of reactivity, and the doubling time are also given as functions of many parameters such as fuel-rod geometry, the surrounding structural materials, coolant, moderator, and fuel density. The bulk of the article is devoted to these and other associated factors that determine neutron economy in fission breeders. (TTT)

Research Reactors

23332 (DC-60-2-230) SHIELD TEST AIR REACTOR (STAR) PROGRAM SUMMARY REPORT. W. D. Wayne, R. A. Lofy, F. D. Kodras, D. T. James, J. C. Young, and D. H. Brown (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Feb. 19, 1960. Contract AT(11-1)-171. 258p.

A description and program history is presented for the Shield Test Air Facility (STAF), its radiation source, and its associated systems. The program costs and schedules are included. (M.C.G.)

23333 (HW-69924) MEASUREMENTS OF RADIOISOTOPES AND TRACE CONSTITUENTS IN THE PRTR D_2O AND HELIUM SYSTEMS. R. W. Perkins and C. W. Thomas (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 14, 1961. Contract AT(45-1)-1350. 13p.

Analysis of the primary coolant, the LiOH which was added for pH control, the primary coolant ion exchange bed, and smears from fuel elements indicated that the I^{131} and fission gases in the concentrations observed came from a leaking fuel element. A calculation of the contribution of recoil fission fragments from the uranium impurity in the zirconium fuel element cladding and process tubes to the observed I^{131} and fission gases indicated that this source is negligible. The uranium in the 100 gallons of light water which was accidentally added to the primary D_2O system was also negligible. The observed Cl^- and F^- concentrations in the primary coolant could not be due to trace impurities in the original D_2O, the added LiOH, or trace elements in 100 gallons of light water which was accidentally added to the primary D_2O system. The high Cl^- and F^- concentrations could possibly be explained by the presence of Freon which might be trapped in the system after pressure testing. (auth)

23334 (ORNL-TM-239) EFFECT OF URANIUM-BEARING SCALE DEPOSITS ON HRE-2 CORE WALL TEMPERATURE, HEAT FLUX, AND PATCH TEMPERATURE. C. G. Lawson and F. N. Peebles (Oak Ridge National Lab., Tenn.). May 29, 1962. Contract W-7405-Eng-26. 26p.

Calculations are presented to show the effect of uranium-bearing scale deposits on the HRE-2 core wall temperature, heat flux, and the temperature of patches proposed for sealing the holes of the HRE-2 core vessel. Flow behavior in the HRE-2 core mockup with simulated patches installed and simulated corrosion pits drilled in the vessel wall was determined. A plausible mechanism was advanced to account for hot spots due to sedimentation of solids on metal surfaces projecting from the core wall. Patch designs with reduced metal projections from the core wall are presented. (auth)

23335 (SC-4680(M)) HEALTH PHYSICS ASPECTS OF THE START-UP AND OPERATION OF THE SANDIA PULSED REACTOR FACILITY (SPRF). William D. Burnett, Harold L. Rarrick, George E. Tucker, and Milton W. Tucker (Sandia Corp., Albuquerque, N. Mex.). May 1962. Contract [AT(29-1)-789]. 21p.

Unusual health physics problems, such as shielding modifications required, encountered with start-up and operation of the Sandia pulsed reactor are described. Included are: integral radiation doses received from primary and scattered neutron radiation; gamma radiation doses resulting from fission products in the reactor itself; and neutron-induced radioactivities in the air, walls, and floor of the reactor building. Also listed are present health physics procedures and personnel dose histories. (auth)

23336 TIME BEHAVIOR OF XENON-POISONING AT THE RESEARCH REACTOR AT GEESTHACHT. Dietrich Buenemann (Institut für Reaktorphysik, Geesthacht, [Ger.]). Kerntechnik, 4: 189-92(May 1962). (In German)

For the research reactor at Geestacht the reactivity change by xenon poisoning as a function of time is calculated for some typical cases. By simple changing of the scale the results can be used for other thermal reactors. (auth)

23337 A REACTOR SIMULATOR FOR TEACHING AND TRAINING PURPOSES. E. Gass, R. Lauber, H. Lauffer, G. Schweizer (Technische Hochschule, Stuttgart). Kerntechnik, 4: 193-7(May 1962). (In German)

The design and basic requirements for a reactor simulator for teaching and training purposes are discussed. It is shown that a simulator with fixed wired programs, which can be selected from a control console by push buttons, fits the necessary requirements. By using suitable mathematical models, which are simulated in program units, the reactor simulator is feasible at reasonable costs. Applying this concept, the reactor simulator can be used to demonstrate and compare the dynamics and operation of various types of nuclear power plants with accuracy. The design of the circuits for the fixed programs is shown and some units are considered in detail. Some experiments that can be performed with the reactor simulator are described. (auth)

23338 EXPERIMENTAL INVESTIGATION OF THE PHYSICAL PARAMETERS OF THE VVR-M REACTOR OF THE INSTITUTE OF PHYSICS OF THE ACADEMY OF SCIENCES OF THE UKRAINIAN SSR. M. V. Pasechnik, I. F. Barchuk, and V. B. Klimentov (Inst. of Physics, Academy of Sciences, Ukrainian SSR, Kiev). Ukrain. Fiz. Zhur., 7: 2-14(Jan. 1962). (In Ukrainian)

The experiments are conducted during the operation of the reactor. Data are given on the critical dimensions of the active zone, the efficacy of the regulating rods, the distribution of thermal neutrons, and data obtained during operation of the reactor at a power level of 5 Mw. (auth)

23339 HAZARDOUS INCIDENTS IN RESEARCH REACTORS. V. Surya Rao, S. L. Kati, A. K. Ganguli, and S. D. Soman (Atomic Energy Establishment, Trombay, India). IAEA Preprint SM-24/19. 16p. (In English)

To be published in the Proceedings of the IAEA Sympo-

sium on Reactor Safety and Hazards Evaluation Techniques held in Vienna, 14-18 May 1962.

An outline is given of incidents that have occurred during the course of operation of the three research reactors "Aspara," CIR, and Zerlina, which could have led to hazardous consequences. "Aspara" has been in operation since August 1956 while CIR and Zerlina have been operating since July 1960 and January 1961 respectively. A survey of incidents in CIR indicates that the majority of incidents resulted from human failures and had taken place during low-power operation. A number of incidents also resulted from both human and equipment failures. A serious view is taken of these incidents particularly because of the grave consequences resulting from release of large amounts of fission product activities had these incidents taken place during high-power operation. Adequate steps have been taken by instituting design modifications and additional administrative controls for preventing recurrence of such incidents. (auth)

23340 ADMINISTRATIVE CONTROL IN REACTOR OPERATION. V. Surya Rao, S. L. Kati, A. K. Ganguli, and S. D. Soman (Atomic Energy Establishment, Trombay, India). IAEA Preprint SM-24/20. 19p. (In English)

To be published in the Proceedings of the IAEA Symposium on Reactor Safety and Hazards Evaluation Techniques held in Vienna, 14-18 May 1962.

The three research reactors at the Trombay Establishment are grouped under the Reactor Operations Division. While day-to-day operations and maintenance are carried out under instructions from the respective Reactor Superintendents, major changes in design, operating policy, and insertion of any experimental assemblies are referred to independent standing committees. Reactor Policy Committee lays down major policy decisions regarding limits for safety parameters, operational program and experiments, whereas the Reactor Safety Committee goes into detailed designs particularly on reactor safety and personnel aspects. Due to the complicated nature of reactor control systems, a Control System Committee is set up to scrutinize proposals involving changes in the existing circuitry with a view to ensure that the change does not adversely affect safe operation of other components. Liaison between operators and users is maintained through Program Committees. All overexposures (internal or external) are referred to Overexposure Investigation Committee for investigation and recommendations. Whereas detailed manuals on design, operation, and testing of different systems have been prepared, a set of important instructions on reactor safety is included. Facilities have been provided for the training of operators as well as engineers in reactor operations. The training program comprises of classroom lectures as well as practical demonstration and includes among other things fire fighting, industrial accidents, and health physics procedures. Procedures are formulated to meet any possible emergency conditions resulting from uncontrolled release of activity. Responsibilities of individual officers for safe operation of the reactors are laid down and terms of reference are strictly adhered to. (auth)

23341 FACILITIES USED FOR STUDYING THE ELECTRICAL PROPERTIES OF SEMI-CONDUCTORS EXPOSED TO NUCLEAR RADIATION. G. Glanz, I. Olteanu, and N. Dutescu (Institutul de Fizică Atomică; Academia R. P. R., Bucharest). IAEA Preprint SM-25/10. 11p. (In Russian)

To be published in the Proceedings of the IAEA Symposium on Radiation Damage in Solids and Reactor Materials held in Venice, Italy, 7-11 May 1962.

Two facilities are described for studying the electrical properties of semi-conductors exposed to nuclear radiation inside the 2000 kw reactor (VVRS type) in the Institute of Atomic Physics, Bucharest. With the first facility, samples can be irradiated at ambient temperature or at higher temperatures. It can also be used for: (a) simultaneous irradiation of a number of samples in identical conditions; (b) cooling samples during irradiation by a jet of cold compressed air; (c) inserting and extracting samples while the reactor is operating at 2000 kw; (d) remote-controlled placing of samples in different positions in relation to the core, so that they can be exposed to different neutron fluxes. The second facility can be used for irradiating at the temperature of liquid nitrogen, with automatic regulation of the nitrogen flow, thus avoiding the accumulation of liquid oxygen in the coolant. (auth)

SPACE APPLICATIONS AND TECHNOLOGY

23342 (AD-269184) ON-OFF PULSED TRANSMISSION LINE FOR PLASMA PROPULSION. Allan B. Schaffer (Aerospace Corp., Physical Research Lab., El Segundo, Calif.). Mar. 8, 1961. Contract AF04(647)-594. 10p. (TDR-594-(1214-01)TN-1)

Huddleston's analysis of on-off pulsed operation of the rail plasma driver is extended to the transmission line-type plasma driver. Both the mode of operation in which the distributed capacitors of the transmission line are originally uncharged and the one in which they are originally charged are analyzed. Theoretically on-off pulsed operation affords the possibility of achieving high efficiencies with either mode of operation. From a practical standpoint, however, the mode with capacitors originally uncharged is seen to be the most feasible. (auth)

23343 (JPL-TR-32-22) MATERIALS PROBLEMS IN SPACE-VEHICLE ENGINE DEVELOPMENT. Robert A. Boundy (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). Apr. 22, 1960. Contract NASw-6. 18p.

Materials problems associated with the design, development, and fabrication of a 6000-lb-thrust tube-bundle liquid-propellant rocket engine are discussed. Particular emphasis is given to thrust-chamber fabrication, including the development of stainless steel tubes and the brazing techniques. Incidental aspects of fabrication are discussed, including the exit skirt, stiffener rings, wire wrapping, and chamber coating. Finally, future developments in the areas of tube fabrication and an uncooled extension nozzle are considered. (auth)

23344 (NASA-TN-D-1213) PERFORMANCE EVALUATION OF A MERCURY-PROPELLANT FEED SYSTEM FOR A FLIGHT-MODEL ION ENGINE. Eugene V. Pawlik and Norman C. Wenger (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). June 1962. 24p.

The propellant feed system, which was evaluated in vacuum facilities, consisted of an electrically heated mercury boiler and a transistorized temperature controller. The boiler was constructed with a porous plug for restricting flow of vaporized mercury and preventing liquid mercury from leaving the boiler during simulated launching. The propellant feed system was capable of reaching steady-state operating conditions after 4-½ minutes of operation and maintaining the propellant flow within 9.0 percent of the desired value with the ion engine operating for 30 minutes at 0.350-amp beam current. (auth)

23345 (NP-11732) USE OF NUCLEAR ENERGY FOR SATELLITES AND SPACE ROCKETS. An Annotated Bibliography with Abstracts and Notes. Oskar Liskowsky, comp. (Kernforschungsanlage, Jülich, Germany). Mar. 1962. 60p.

An annotated bibliography containing 172 references with abstracts is presented. Author, corporate, journal, and report number indexes are included. (N.W.R.)

WASTE DISPOSAL AND PROCESSING

23346 (CRCE-1080) A WASTE DISPOSAL EXPERIMENT USING MINERAL EXCHANGE ON CLINOPTILOLITE. W. G. Mathers and L. C. Watson (Atomic Energy of Canada Ltd., Chalk River, Ont.). Jan. 1962. 35p. (AECL-1521)

An 8200-liter volume of waste solution containing 400 curies of Cs-137 and 370 curies of Sr-90 was treated by ion exchange with clinoptilolite, a natural zeolite. The Cs and Sr were removed from solution by this treatment and the loaded mineral was buried in a concrete container in the Chalk River B disposal area. Both the preliminary laboratory work and the full-scale operation are described. (auth)

23347 (HW-72215) PILOT SCALE ALUMINUM BED DECONTAMINATION OF REACTOR EFFLUENT. II. FINAL REPORT. H. G. Rieck (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 1962. Contract AT(45-1)-1350. 45p.

An aluminum bed 20 feet long, 3 feet wide and 6 feet deep was designed and fabricated. Reactor effluent was fed through the bed at an initial linear velocity of 3.8 fpm. Subsequently, the bed was operated at 6, then 2.7 fpm. Operation characteristics were established at the stated flow rates. Aluminum-filled column experiments were conducted during production tests involving water treatment changes. These experiments showed that low dichromate, high alum, or aluminum nitrate substituted for aluminum sulfate have minor, if any, effect on the decontamination efficiency. Aluminum-filled troughs were used to evaluate the effect on decontamination efficiency of two effluent water pretreatments. A reduction of the pH resulted in a slightly improved decontamination efficiency. Reduction of dichromate with bisulfite prior to passage through the bed caused an insignificant change in decontamination efficiency. (auth)

23348 (ORNL-TM-169) WASTE TREATMENT AND DISPOSAL PROGRESS REPORT FOR DECEMBER 1961 AND JANUARY 1962. R. E. Blanco and E. G. Struxness (Oak Ridge National Lab., Tenn.). Contract [W-7405-eng-26]. 68p.

Progress in the development and demonstration on a pilot plant scale integrated processes for treatment and ultimate disposal of radioactive wastes is reported. Topics covered include: high-level waste calcination; low-level waste treatment; engineering, economics, and hazards evaluation; disposal in deep wells; disposal in natural salt formations; Clinch River study; fundamental study of minerals; and White Oak Creek basin study. (M.C.G.)

23349 EFFLUENT AT WINDSCALE AND THE EFFECT OF THE CIVIL POWER PROGRAMME. Atom, No. 68, 123-39(June 1962).

Over the next ten years the electrical power generated by British nuclear stations is expected to rise about 20 times that at present being generated by the reactors at Calder Hall and Chapelcross. The amount of fission product waste produced by the power stations will increase in proportion to the power generated. Methods used for waste processing and disposal at present are described. Measures planned to handle the waste from the expanding nuclear power program are described. (C.H.)

23350 THE REMOVAL OF RADIOACTIVE WASTES FROM ISOTOPE LABORATORIES. D. Voedroes. Kernenergie, 5: 184-6(Mar. 1962). (In German)

A collection system for radioactive wastes was described. The radioisotope laboratories collect the waste according to their aggregate state. Within the aggregate states a further division is made into three groups according to half lives. The solid radioactive wastes were collected in PVC sacks. When a sack is filled, it is then removed. The liquid wastes were collected in polyethylene jugs, and the animal cadavers in 25-liter milk cans coated with bitumen. The collected wastes were repacked in a second PVC sack and sent to a central depot. Concrete shafts buried in the ground were used for the deposition of the waste. The planned volume reduction is still unrealized. The collection system is economic, tested, and satisfies the legal requirements. (tr-auth)

23351 PURIFICATION OF RADIOACTIVE WASTE SOLUTIONS WITH NATURAL INORGANIC ION EXCHANGERS. IV. THE EXTRACTION BEHAVIOR OF RADIOACTIVE IGNITION PRODUCTS OF RADGENDORF CLAYS. G. Sachse (Zentralininstitut für Kernphysik, Rossendorf, Ger.) and E. Leibnitz. Kernenergie, 5: 187-90(Mar. 1962). (In German)

After a brief discussion of the effect of heat treatment on bentonitic clays, lattice modifications of Radgendorf clays between 700 and 1000°C were illustrated with Debye-Scherrer diagrams. The activity escape from charged ion exchangers after various heat treatments was represented by extraction curves for Cs, Sr, and Ce. Orienting investigations show that the Radgendorf bentonite is suitable as a material for the preparation of radioactive melts. Fusion products of the clays with Cs, Sr, and Ce ions gave values of 0.1 to 0.001% for the extractable ion mass. A prior leaching of the surface of the fusion products decreased, with a simultaneous extraction at 80°C, the activity released by an order of magnitude. (tr-auth)

CORPORATE AUTHOR INDEX

This index contains entries for all report literature and, in addition, for certain published literature items for which it is felt that a corporate approach is especially desirable, e.g., symposia, conference proceedings, and meetings.

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Æ	becomes	ae
Ö		oe
œ		oe
Ü		ue (except in transliterated Chinese names)

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All reports, translations, and patents abstracted in this issue are included in this index. Each item is listed by report number; this is followed by the abstract number and a brief notation regarding public availability. The index entries show, when known, which reports are on file in the depository libraries, which reports have been published in open-literature journals (journal citation given), and which reports can be purchased (source and price). Whenever a report is identified by more than one number, cross references from secondary to primary report numbers are cited.

The report number codes apply to AEC reports unless designated otherwise. Non-AEC reports are identified by parenthetical notes after the report codes; e.g., (non-AEC), (British), (Canadian), (French). The note (Misc.) identifies those codes used for both USAEC and non-AEC reports. The report numbers for the non-AEC reports in these series are marked with an asterisk (*). Patents are listed under the heading "PATENTS"; the country of origin is included in parentheses.

A comprehensive listing of both AEC and non-AEC report codes is contained in TID-85(2nd Rev.), *Report Number Series Used by the Technical Information Service in Cataloging Reports*. March 1960, $2.75 (OTS), and supplement, August 1960, $0.50 (OTS).

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2275 & Rev.	16-23286	Nuclear Sci. and Eng. 13: 153-65(1962)
2451(Vol.I)	16-22984	Dep.; $3.50(OTS)
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2241	16-22030	J. Appl. Phys. 33: 1904(1962)
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19	16-23245	
NLCO–		
849	16-22565	Dep.; $0.75(OTS)
NMI–	**(Misc.)**	
7248	16-23321	Dep.(mc); $2.60(fs), $0.98(mf) OTS

Report No.	Abstract No.	Availability
NP–	**(AEC File No. for Non-AEC Reports)**	
11379	16-22430	Dep.(mc)
11529	16-22162	
11548	16-22003	
11610	16-23178	
11638	16-22403	
11648	16-21912	Dep.(mc)
11704	16-22431	Dep.(mc)
11721	16-22495	
11723	16-22496	
11724	16-22497	
11725	16-22498	
11727	16-22499	
11730	16-22652	
11732	16-23345	Dep.(mc)
11747	16-22985	Dep.(mc)
11750	16-21913	
11761	16-22852	Dep.(mc)
11764	16-22050	Dep.(mc)
11766	16-22727	Dep.(mc)
11777	16-22566	Dep.(mc)
11795	16-22593	
11823	16-23322	Dep.(mc)
11838	16-22853	
NP-tr–	**(AEC File No. for Non-AEC Translations)**	
879(Pt.I)	16-22074	Dep.(mc); $1.10(fs), $0.80(mf) JCL or OTS
879(Pt.II)	16-22075	Dep.(mc); $1.10(fs), $0.80(mf) JCL or OTS
896	16-22308	Dep.(mc); $2.60(fs), $1.10(mf) JCL
NS–	**(New Zealand)**	
7	16-22500	Dep.(mc)
NYO–		
4814	16-22432	Dep.(mc); $7.60(fs), $2.42(mf) OTS
7989	16-23179	Dep.(mc); $2.60(fs), $1.10(mf) OTS
9189	16-23180	Dep.(mc); $2.60(fs), $0.92(mf) OTS
9575	16-22501	Dep.(mc); $3.60(fs), $1.34(mf) OTS
9790	16-23273	Dep.(mc); $15.50(fs), $7.19(mf) OTS
9843	16-23272	See NDA-2169-3
10134	16-22728	Dep.(mc); $1.60(fs), $0.80(mf) OTS
ORNL–		
3268	16-22986	Dep.; $2.50(OTS)
ORNL-TM–		
150	16-21994	Dep.(mc); $4.60(fs), $1.46(mf) OTS
169	16-23348	Dep.(mc); $6.60(fs), $2.24(mf) OTS
220	16-22567	Dep.(mc); $1.60(fs), $0.80(mf) OTS
239	16-23334	Dep.(mc); $2.60(fs), $0.98(mf) OTS
256	16-22051	Dep.(mc); $1.10(fs), $0.80(mf) OTS
258	16-22052	Dep.(mc); $1.60(fs), $0.80(mf) OTS
ORO–		
552	16-22568	Dep.(mc); $2.60(fs), $0.89(mf) OTS
557	16-22569	Dep.(mc); $1.10(fs), $0.80(mf) OTS
561	16-22729	Dep.(mc); $1.10(fs), $0.80(mf) OTS
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3	16-22981	Postepy Tech. Jadrowej No. 2, 183-96(1961)
4	16-23331	Postepy Tech. Jadrowej No. 4, 559-82(1961)
PAN–	**(Polish)**	
288/ChR	16-22163	Dep.
296/XVII	16-22164	Dep.
297/I-B	16-23007	Dep.
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3,039,945	16-23302	
3,039,946	16-23303	
3,039,947	16-23304	
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3,039,975	16-22509	
3,040,175	16-22392	
3,040,209	16-23243	
3,041,134	16-23306	
3,041,262	16-23307	
3,041,264	16-23308	
3,041,282	16-22540	

Report No.	Abstract No.	Availability
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3,041,454	16-22394	
3,041,455	16-22395	
3,041,457	16-22396	
PATENTS	**(U.S.S.R.)**	
133,269	16-22009	
PB–	**(Non-AEC)**	
171810	16-22399	See PLASTEC-NOTE-1
PG-Report–	**(British)**	
317	16-22004	Dep.
325	16-22005	Dep.; $0.21(BIS)
334	16-22006	Dep.
336	16-22007	Dep.
PLASTEC-NOTE–	**(Non-AEC)**	
1	16-22399	OTS
PPAD–		
431-E	16-23126	Phys. Rev., 126: 1189-94(1962)
PST-Cat.–	**(Misc.)**	
382	16-22060	See AEC-tr-4460
RADC-TN–	**(Non-AEC)**	
61-226	16-21914	OTS
RM–	**(Misc.)**	
3005-PR*	16-22404	OTS
RME–		
4511	16-22405	Dep.; $0.50(OTS)
4540(Rev.)	16-22406	Dep.; $0.50(OTS)
SB–	**(Non-AEC)**	
477	16-21858	$0.10(OTS)
491	16-21997	$0.10(OTS)
492	16-21996	$0.10(OTS)
493	16-21998	$0.10(OTS)
494	16-21869	$0.10(OTS)
SC–	**(Misc.)**	
4580(M)	16-23335	Dep.; $0.50(OTS)
SCDC–		
2673	16-22524	See TID-15780
2686	16-22653	See TID-16102
2688	16-22330	See TID-16041
SCL-T–		
422	16-22168	Dep.(nc); $4.60(fs), $1.46(mf) JCL
SCTM–		
335-61(71)	16-22302	Dep.; $1.60(fs), $0.80(mf) OTS
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SIT-P–	**(Misc.)**	
54*	16-23161	OTS
SPM–	**(French)**	
423	16-22968	
STI-PUB–	**(International Atomic Energy Agency)**	
34(Vol.I)(p.185-93)	16-22166	For translation see AEC-tr-5094
TCREC-TR–	**(Non-AEC)**	
61-127	16-22491	See AD-269483
TDR–	**(Non-AEC)**	
594-(1214-01)TN-1	16-23342	See AD-269184
TEI–		
780	16-22407	Dep.; $1.00(OTS)
814	16-22408	Dep.(nc); $3.60(fs), $1.34(mf) OTS
818	16-22409	Dep.(nc); $8.10(fs), $2.84(mf) OTS
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7632	16-22433	Dep.; $5.75(OTS)
15438	16-23323	Dep.(nc); $4.60(fs), $1.46(mf) OTS
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15789	16-22287	Dep.(nc); $6.60(fs), $2.21(mf) OTS
15817	16-22410	Dep.(nc); $5.60(fs), $1.91(mf) OTS
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669	16-22331	Dep.(nc); $1.10(fs), $0.80(mf) OTS
TM–	**(Misc.)**	
62-6-3	16-22073	See AEC-tr-5167
TR–	**(Misc.)**	
490-1*	16-22316	See AD-269309
TT–	**(Canadian)**	
1022	16-22010	Dep.(nc); NRC or JCL
UCRL–		
842	16-23166	Dep.(nc); $1.60(fs), $0.80(mf) JCL
5733	16-23187	J. Appl. Phys. 33: 1987-99(1962)
5999	16-22572	Metal Progr. 82: No. 1, 93-5(1962)
6523	16-21867	Dep.; $0.75(OTS)
6807	16-22305	Dep.; $0.75(OTS)
6865	16-22596	Dep.; $0.50(OTS)
9868	16-22772	J. Math. Phys. 3: 557-63(1962)
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9891	16-23108	Phys. Rev., 126: 1004-8(1962)
9925	16-22912	Phys. Rev. 126: 1202-8(1962)
9987	16-22057	$1.75(OTS)
10059	16-22525	$1.50(OTS)
10108	16-22058	Dep.; $1.75(OTS)
10135	16-22059	Dep.; $2.50(OTS)
10181	16-21916	Dep.; $0.50(OTS)
UCRL-Trans–		
792(L)	16-23012	Dep.(nc); $4.60(fs), $1.64(mf) JCL
829(L)	16-22737	Dep.(nc); $2.60(fs), $0.83(mf) JCL
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556	16-21917	
559	16-22332	
560	16-21918	
WADD-TR–	**(Non-AEC)**	
59-303(Pt.II)	16-22530	See ARF-3133-23
60-924	16-22597	OTS
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1473	16-22288	Dep.(nc); $2.60(fs), $0.92(mf) OTS
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XDCL–		
60-5-131	16-22570	Dep.(nc); $1.60(fs), $0.80(mf) OTS
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